Iron AND Steel ENGINEER

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FASTEST COLD MILLS IN THE WORLD Built by

MESTA

MESTA 42" High Speed Four-High Tandem Cold Mill for Rolling Tin Plate Gauges

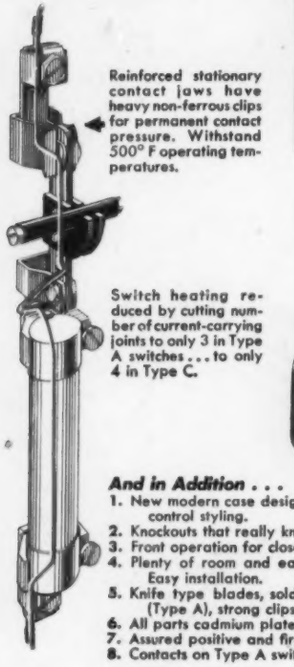
The Army-Navy "E" flag with five stars flies over the Mesta Plant

MESTA MACHINE COMPANY · PITTSBURGH, PA.

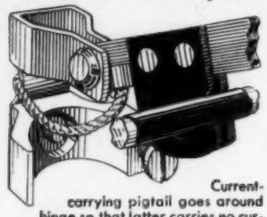
✓R 23' Jan-June 1946

A *New* AND *Better* SAFETY SWITCH

Features of the new and better C-H Safety Switch



Reinforced stationary contact jaws have heavy non-ferrous clips for permanent contact pressure. Withstand 500° F operating temperatures.



Current-carrying pigtail goes around hinge so that latter carries no current. A feature promoting better operation and longer life in Type A switches.

Switch heating reduced by cutting number of current-carrying joints to only 3 in Type A switches . . . to only 4 in Type C.

Perfected arc snuffer confines arc to restricted space and wipes remaining arc from blade as switch is opened. Snuffer readily removed to inspect jaw contact.

And in Addition . . .

1. New modern case design that matches Cutler-Hammer motor control styling.
2. Knockouts that really knock out.
3. Front operation for close ganging.
4. Plenty of room and easy access to shape up wires inside. Easy installation.
5. Knife type blades, solderless lugs, screw type fuse clamps (Type A), strong clips.
6. All parts cadmium plated against corrosion.
7. Assured positive and firm contact even after long use.
8. Contacts on Type A switches are silver plated.

To beat the heat that *all* safety switches generate while they are "on" . . . Cutler-Hammer Engineers designed a NEW Safety Switch. Their first step was to plan a switch mechanism that would carry its load with a new low minimum of heating. Their second step was to build the mechanism so that it would far better withstand the heat produced by the fuses in normal operation. Finally they added plus features which a thorough investigation over a long period of time showed that contractors, electricians and service men want.

The result is an outstanding switch that offers better performance, longer life, easier installation, better appearance, a new measure of safety . . . a switch such as you have never encountered before. Why don't you take the measure of its quality in your very next installation? At Cutler-Hammer wholesalers everywhere. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin.

CUTLER·HAMMER
SAFETY SWITCHES
C-H

Tech.

2-B-50
Tent

Aetna Standard announces

REVOLUTIONARY NEW ADVANCE IN COLD DRAWING

automatic rack-type drawbench

*** FOR TUBES AND BARS, FERROUS AND NON-FERROUS**

Here is a milestone in cold drawing!

This new rack-type drawbench eliminates chain, sprockets, skid arms, and the conventional carriage return drive.

Combining of pulling carriage and drive enables the operator to have complete control over the carriage at all times. The pull is steady—no jerky, grabbing motions. The bars or tubes drop through the bench into storage cradles automatically.

Starting at zero speed, the draw uniformly accelerates to pre-determined drawing speed. Near the end of the draw, the bar or tube automatically decelerates to low speed, which prevents damage to material as it leaves the die. Electronic controls assure positive operation.

Many unique design features result in the following advantages over conventional cold drawing equipment:

(1) Better quality of product; (2) minimum maintenance; (3) more efficient production . . . all of which add up to lower cost per cold drawn foot.

Write to the AETNA-STANDARD ENGINEERING CO. for complete information on the new rack-type drawbench . . . or other cold drawing equipment.

THE AETNA•STANDARD
ENGINEERING COMPANY.
YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

"PEACE" WORK ON A *tonnage* BASIS!

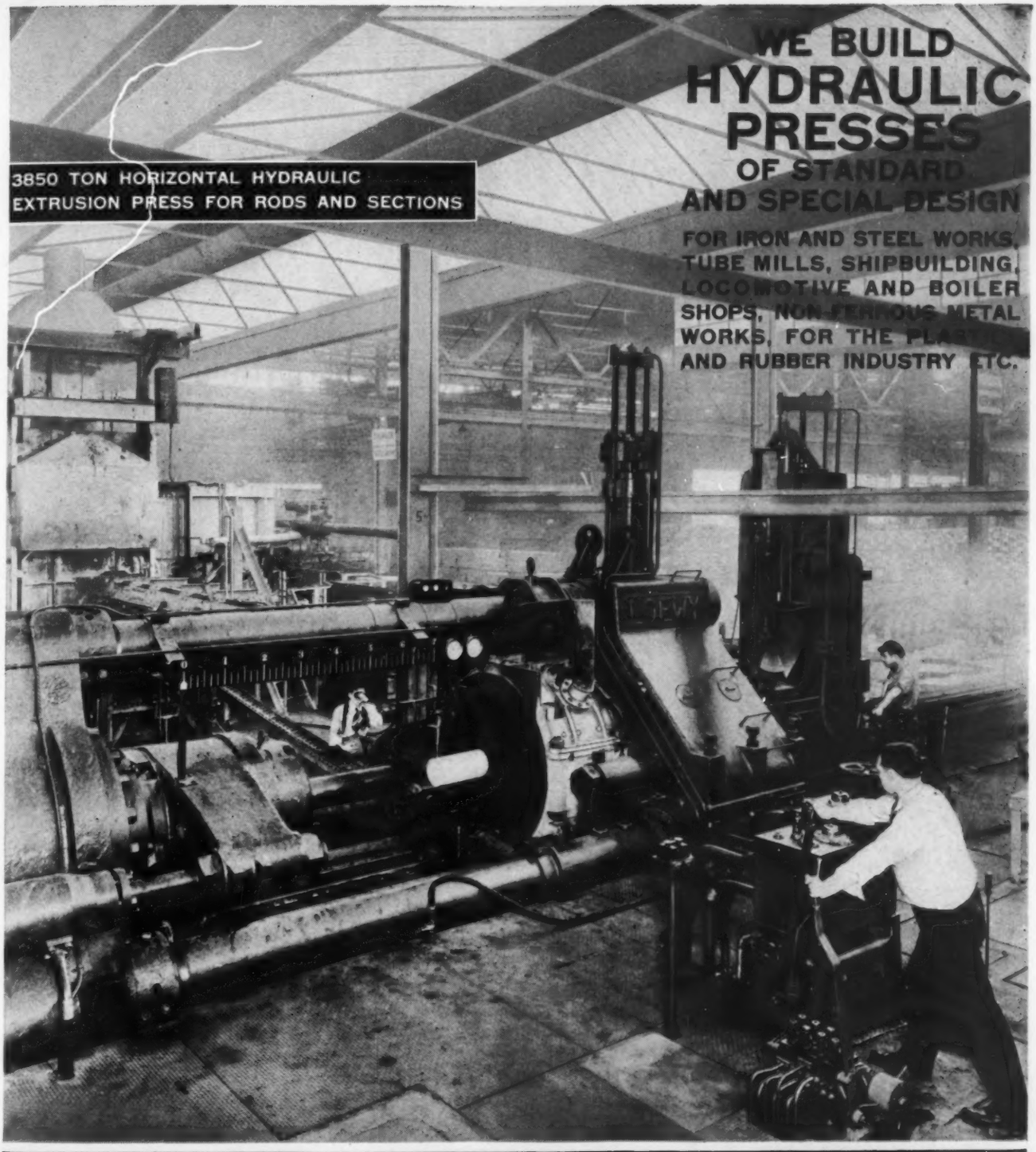
Today, with the steel industry on the threshold of a greater era, and geared to produce on a huge scale, *good rolls* are more important than ever. And **NATIONAL**, with new skills and metallurgical techniques added to those acquired in the past, is ready to furnish the *good rolls* you need, when you need them.

We have the equipment, the experience, the research facilities, and the *will* to give you real roll service — service that extends from basic engineering design through controlled casting and precision machining to delivery as scheduled — roll service, that in terms of tonnage formed and long life, fully meets every expectation.

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

Manufacturers of: ALL GRADES OF CAST ROLLS • IRON & ALLOY IRON STEEL & ALLOY STEEL • HEAVY IRON & STEEL CASTINGS • ROLLING MILL EQUIPMENT



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Airco Processes Help

Flame Scarfing with Airco heavy duty scarfing torches gives billets, slabs and blooms a quick conditioning prior to rolling.

MORE and more the steel industry is using Airco performance-proved oxyacetylene flame and electric arc methods for production speed, economy and flexibility. These versatile modern "tools" provide valuable aid in many ways — by speedily cutting up scrap and ladle skulls for charging, cropping ingot hot tops and bottoms, oxygen lancing, flame cutting and electric welding for maintenance and new construction.

The illustrations on these pages show just a few of the many Airco processes widely used by the steel industry. For helpful technical information in applying these processes to your particular problem — write Airco's Technical Sales Division. Address your nearest Air Reduction office, or Dept. IS in New York. An interesting booklet: "Oxygen—Indispensable Servant of Industry" is also available. Send for your FREE copy today.

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Speed Steel Production

Electric Arc Welding quickly fabricates a buck stay for an open-hearth furnace to replace a burned-out stay.

Flame Cutting by hand saves valuable time on many jobs. It is widely used by industry to quickly trim plate to size; for making replacement parts, dismantling and many other production, maintenance and salvage jobs.

Machine Gas Cutting opens the way to important savings of production time and cost when cutting heavy slabs, ingots and many other large, thick sections. The Airco Heavy Duty Radiagraph shown here is especially designed for flame cutting very heavy sections (20" to more than 40") from carbon and alloy steels. For further information send for bulletin ADR-21.

Oxyacetylene Welding speedily repairs an open-hearth furnace door frame, worn thin in normal service. Weak spots are strengthened by patches welded into place with the hand torch.

Braze Welding (building up with bronze metal) restores innumerable worn or damaged parts to service quickly—with minimum interruption to production. An effective method of making repairs—often without dismantling equipment.

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What one new grease is doing

in the toughest steel mill service!

Get this Complete Lubrication Program for all your machines

- Lubrication Study of Your Entire Plant
- Recommendations to Improve Lubrication
- Lubrication Schedules and Controls
- Skilled Engineering Counsel
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DEVELOPED especially for severe steel mill service . . . proved on the toughest jobs during the toughest production period in history . . . Gargoyle Grease Sovarex L, is ready now to help you protect your bearings . . . and production.

Here are facts and figures reported by operators already using this patented Socony-Vacuum lubricant:

Gargoyle Grease Sovarex L, stands up under heavier pressures than any other grease. It resists softening under temperatures as high as 450° F. It sticks on the job despite the washing effect of water.

This one new grease is in use in no less than 56 different lubricating jobs in some mills. It has been known to double the life of bearings.

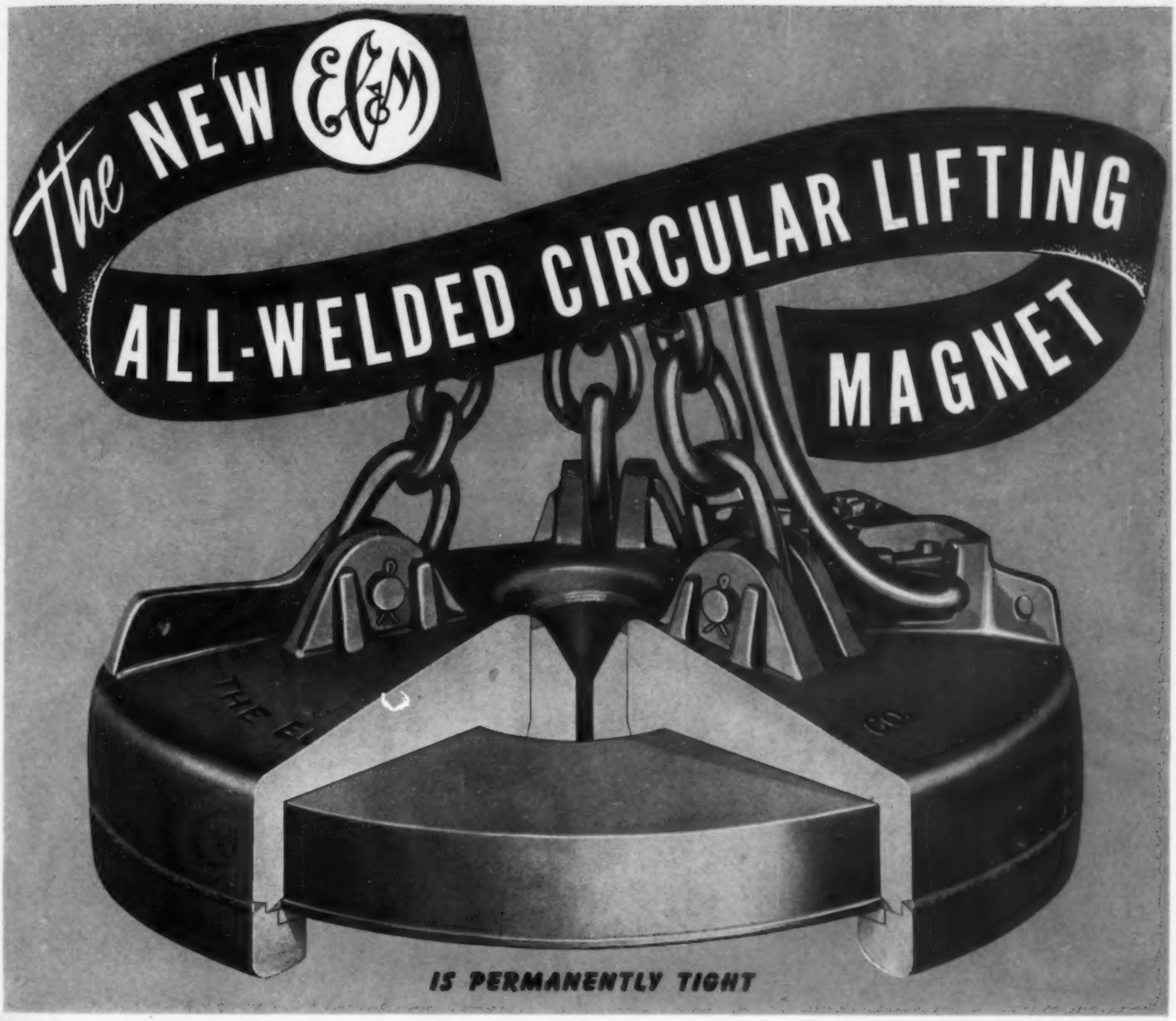
Gargoyle Lubricants

Socony-Vacuum Oil Co., Inc.

and Affiliates: Magnolia Petroleum Co. · General Petroleum Corp. of Calif.

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.S.T.—NBC

The NEW E&M ALL-WELDED CIRCULAR LIFTING MAGNET



Type SW 39-inch diameter Lifting Magnet with full load of steel punchings.

No pole-shoe bolts to stretch and allow an air gap between shoes and magnet-housing. *Instead, continuous welds on both inner and outer poles insure a permanent contact between shoes and magnet-housing.* No gasketed or machined joints to open up and allow moisture to enter the coil-winding. *The Type SW Magnet-winding is sealed in a metal-enclosure by continuous welds which is, in turn, continuously welded into the magnet-housing.* No compound to leak out and require replacement. *The new No. 282, thermo-setting compound is polymerized to a stable condition—it will not melt, nor become brittle, yet is resilient and acts as a cushion between winding and coil-case, (it clings to metal).* Booklet 900 shows the many interesting construction features of these Type SW *All-Welded* Lifting Magnets. They are built in five sizes from 39-inch diameter up for handling scrap, pig iron, slabs, skull cracker balls, turnings, under-water salvage work, etc. Write for your copy of Booklet 900.

The ELECTRIC CONTROLLER & MANUFACTURING CO.

2698 E. 79th ST. CLEVELAND 4, OHIO

No. 13 of a Series: "Looking at the FIVE ESSENTIAL THINGS you never see in ELECTRODES."

IMPROPER storage and handling can seriously damage the careful surfacing, end facing, and precision threading of your "National" carbon or "Acheson" graphite electrodes.

That is why National Carbon Company, Inc., has just designed a new electrode storage rack. It's highly practical, economical, and easy to construct. Each tier in the new rack is independent of the others. The members on which the electrodes rest increase in length at each end from the top of the rack down, to facilitate loading and unloading. The rack can be built to store a carload or more of electrodes of any size.

Need design help? If you need aid in adapting this rack to your plant, or have a special electrode storage problem, National Carbon engineers will be glad to assist.

Designing this new rack . . . and helping you with special storage problems . . . is *customer service*—one of the five essential things you never see in "National" and "Acheson" electrodes. The others: selection of raw materials, manufacturing experience, manufacturing control, and continuing research. All combine to give you greater all-round value in "National" or "Acheson" electrodes.

NATIONAL CARBON

ACHESON GRAPHITE

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Unit of Union Carbide and Carbon Corporation
UCC
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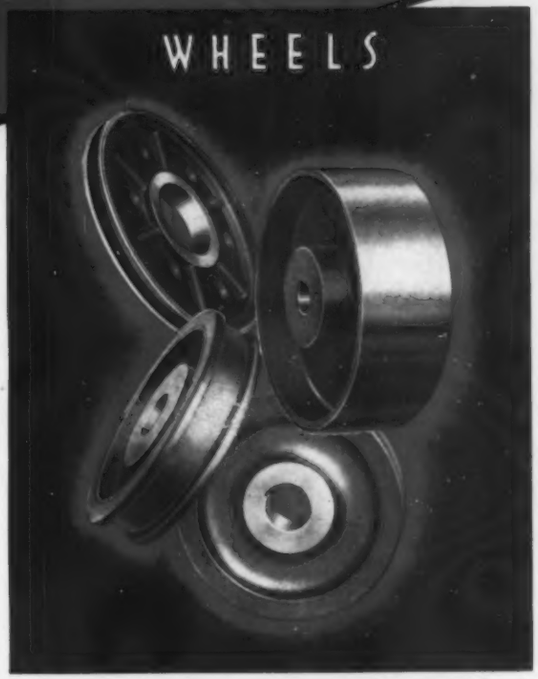
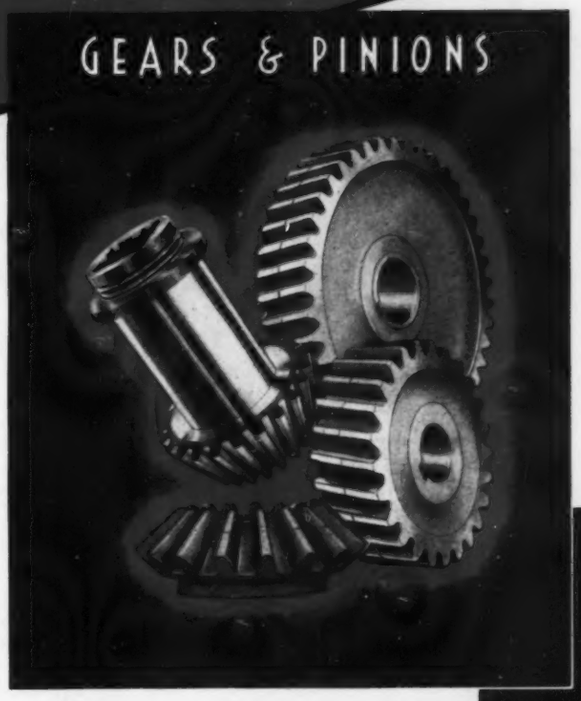
DIVISION SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: Canadian National Carbon Company Limited, Toronto 4, Canada

"TOOL STEEL" PROCESS





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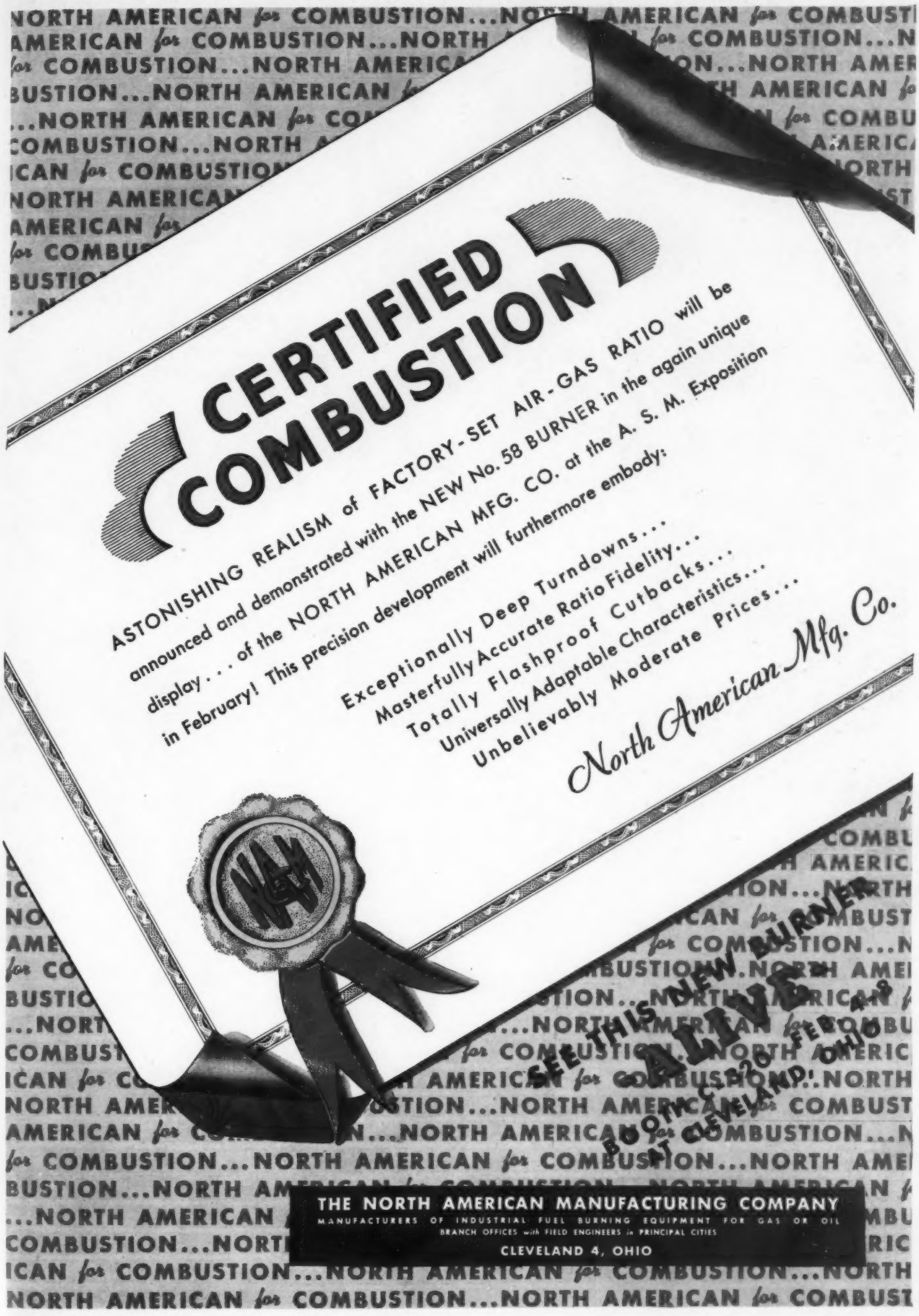
Timken Roll Neck Bearings Are Being Used On 85 Of The 91 New Mill Stands Ordered From January 1 To December 1 Inclusive—Over 93%.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

P. S. *You can't mistake a Timken Bearing for any other type—because the trade-mark "TIMKEN" is on every bearing.*

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
ROLL NECK BEARINGS


NORTH AMERICAN for COMBUSTION...NORTH AMERICAN for COMBUSTION
CERTIFIED COMBUSTION
ASTONISHING REALISM of FACTORY-SET AIR-GAS RATIO will be announced and demonstrated with the NEW No. 58 BURNER in the again unique display . . . of the NORTH AMERICAN MFG. CO. at the A. S. M. Exposition in February! This precision development will furthermore embody:
Exceptionally Deep Turndowns . . .
Masterfully Accurate Ratio Fidelity . . .
Totally Flashproof Cutbacks . . .
Universally Adaptable Characteristics . . .
Unbelievably Moderate Prices . . .
North American Mfg. Co.
SEE THIS NEW BURNER ALIVE
BOOTH C-20 FEB 4-8
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THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES with FIELD ENGINEERS in PRINCIPAL CITIES
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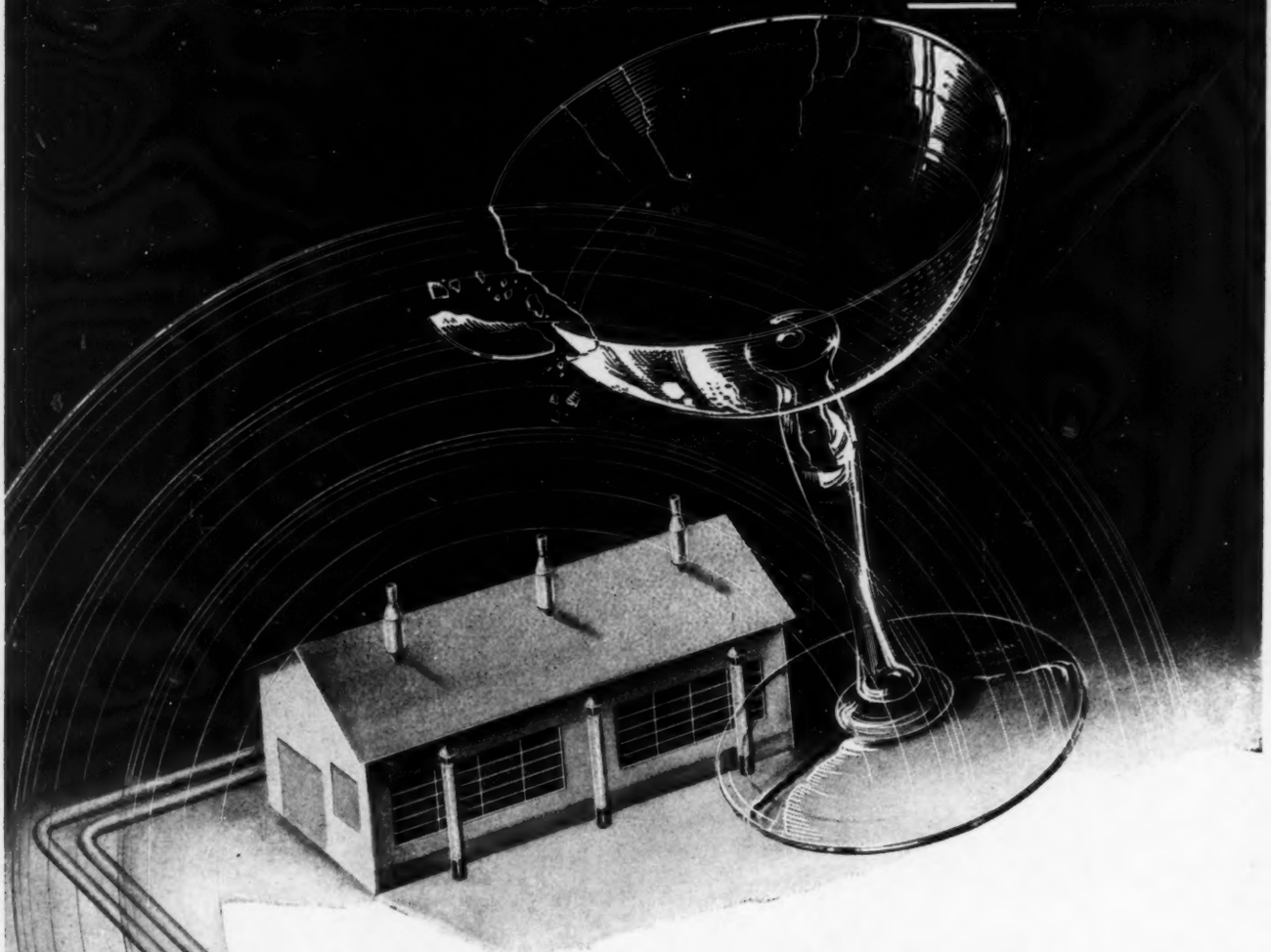
DOES PULSATION PLAY TRICKS IN YOUR PLANT?



Shatter a champagne glass at ten paces just by the sound of your voice? Sounds incredible! But, Caruso could do it. His vocal chords, by setting up air waves of sufficient pitch and intensity, produced vibrations in the glass severe enough to shatter it. Although Caruso's feat is rare, the effects of air waves are not. They are constantly playing havoc with objects far more durable and more expensive than champagne glasses.

For example, there is the phenomenon which recently occurred in the Compressor Plant of a large Eastern Gas Company. Here the compressor house and an auxiliary building were constructed parallel to each other, 24 feet apart. When the plant was put into operation, the main engine air intakes... installed between these two buildings... created so great an air surge as to cause both buildings to vibrate dangerously. A FLUOR Pulsation Dampener was installed in each air intake line. By reducing the air surge substantially, all vibration due to that cause was eliminated.

The FLUOR Pulsation Dampener changes pulsative flow into smooth, steady flow... with beneficial effect on frictional losses, horse-power savings and rate of flow. If vibration plays tricks in your plant, it may be due to pulsations in air, gas or vapor lines. In that case, the FLUOR Pulsation Dampener is your answer.

fc SINCE 1890

FLUOR PULSATION DAMPENER

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ENGINEERS • MANUFACTURERS • CONSTRUCTORS

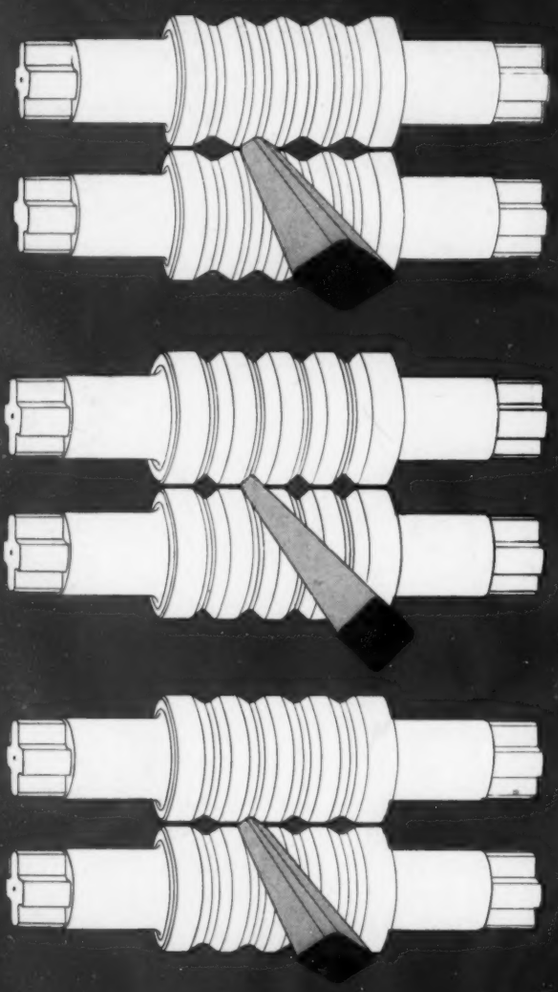
Peacetime PIN-UP

For more than three-quarters of a century . . . manufacturers of rolls and rolling mill machinery for ferrous and non-ferrous industries the world over.

LEWIS FOUNDRY & MACHINE

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

ROLLING TECHNIQUE . . .



Billets

Billet Mills are designed and built with the prime purpose of producing high tonnages of semi-finished steel. This requires rolls that will stand up over a long period and still retain a smooth surface, thus keeping billet reconditioning cost at a minimum.

Pittsburgh Rolls are made by skilled craftsmen whose thorough practical knowledge of metallurgy, foundry methods and accuracy in roll turning is the accumulated result of over seventy-five years devoted to the exclusive manufacture of Rolling Mill Rolls. The use of Pittsburgh Rolls can result only in *less cost per ton of steel rolled.*

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Division of Blaw-Knox Company
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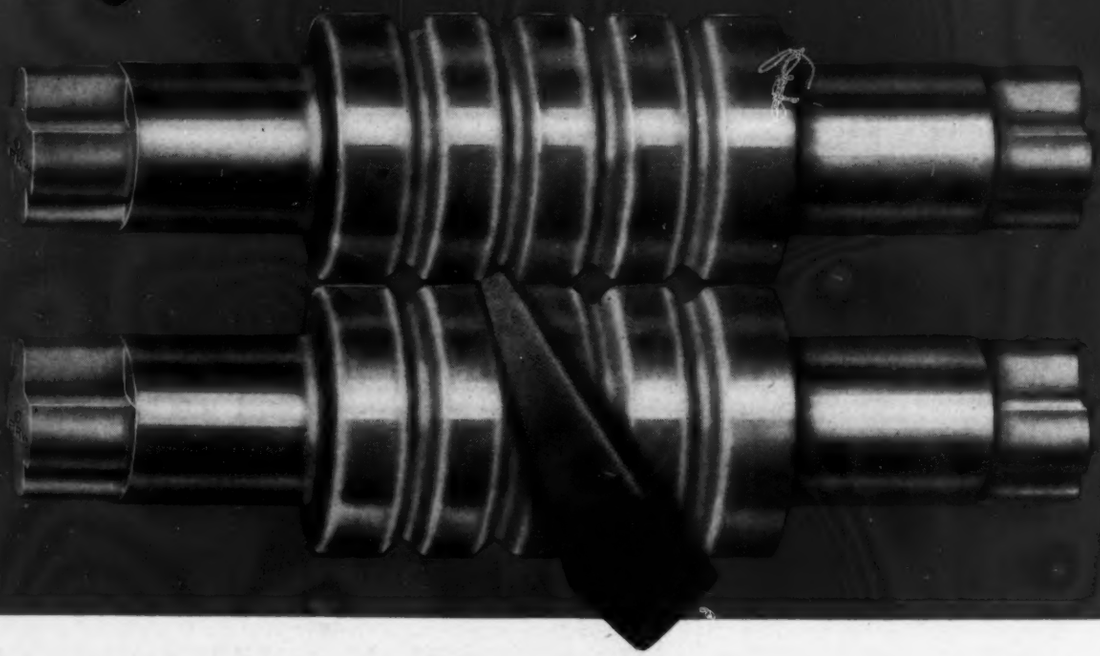


PITTSBURGH ROLLS

meet the new CHAMP!

This new champion of lower heating costs already stands head and shoulders above the crowd, challenging the attention of every large scale producer of ferrous and nonferrous metal products requiring heat treatment. He is the embodiment of the F. E. I. Direct Fired System of Heat Treating, notably in Cover Annealing, Bright Annealing, Spheroidizing and Normalizing Furnaces for coiled strip; tin plate; flat sheets; wire; and rod. Wherever installed these furnaces have so far surpassed other equipment in quality and quantity of output, as to break all records for low unit cost.

Installation of complete new F. E. I. equipment, or F. E. I. modernization of your old cover annealing furnaces, are projects holding big possibilities in your postwar planning for increased production or lower cost.

OTHER F. E. I. PRODUCTS

Galvanizing Furnaces, for pipe, sheet and custom shops.

Galvanizing, Patenting, Lead Annealing and Salt Furnaces for the Wire Industry.

Ask for information, including service records on F. E. I. equipment in important iron and steel plants.

F.E.I.

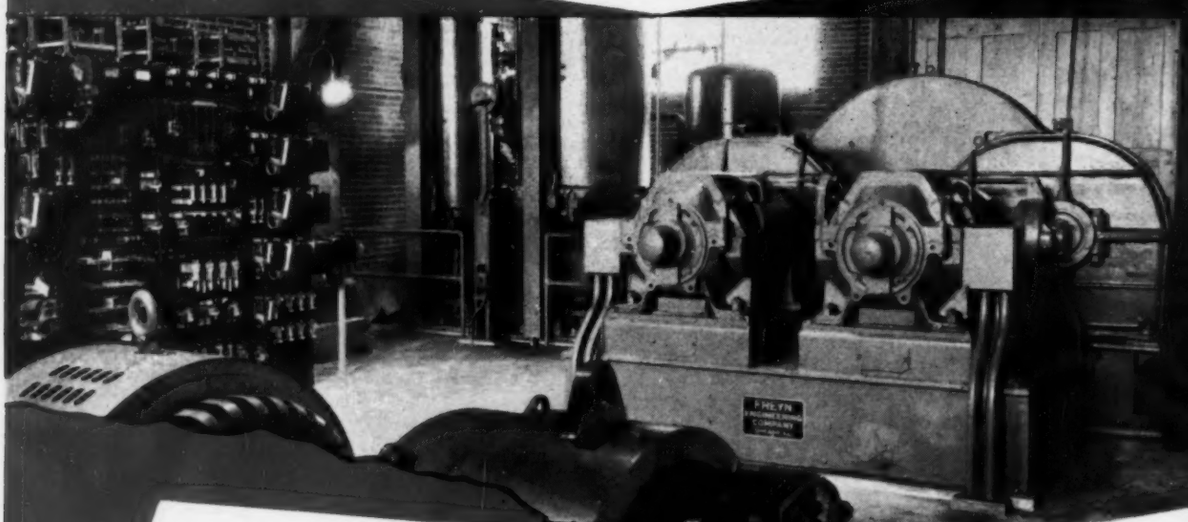
FURNACE ENGINEERS, Inc.

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA

BETTER blast furnace SKIP HOISTS

are built . . .



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Superior in . . .

PERFORMANCE
RELIABILITY
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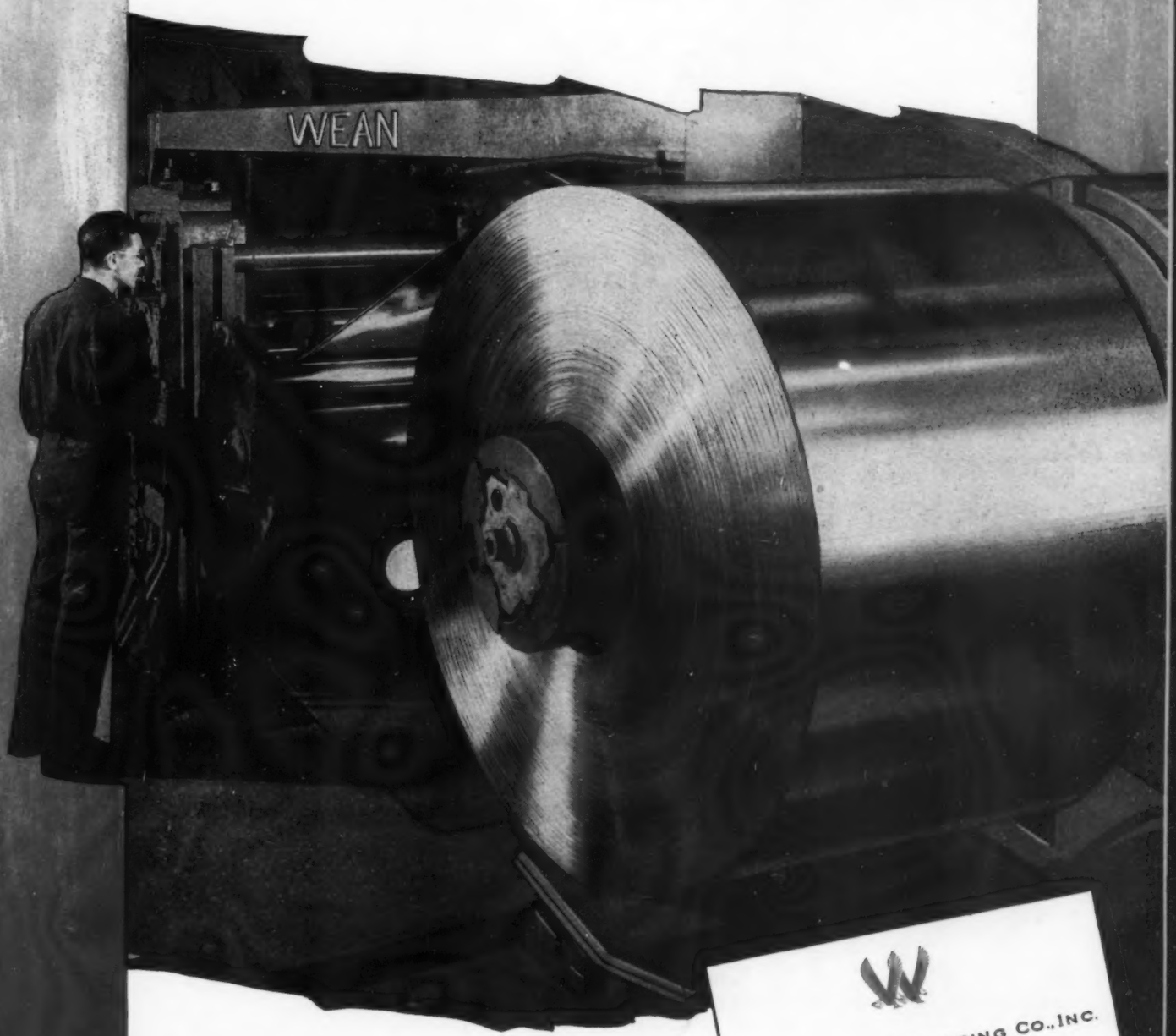
WEAN Pay-Off and Winding Reels are designed to handle the largest coil weights made today



THE WEAN ENGINEERING CO., INC.
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SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

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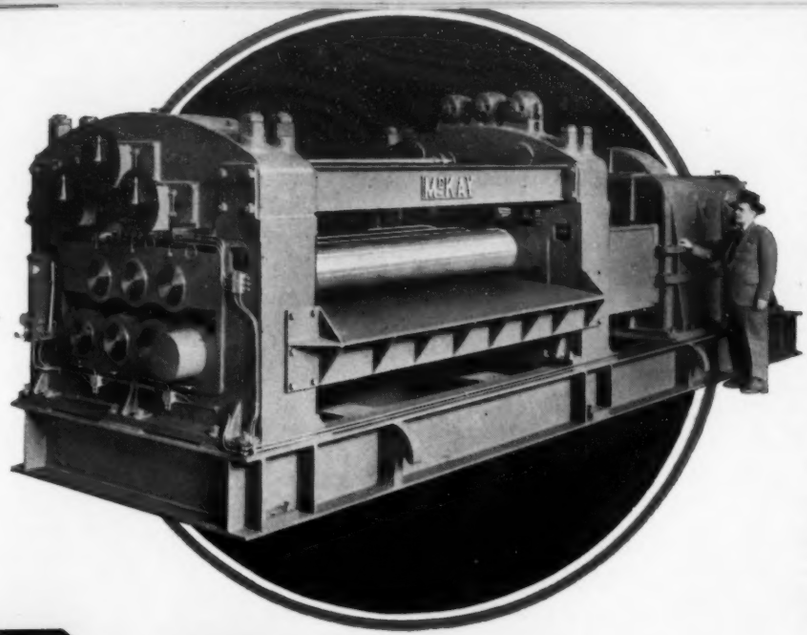
LEVELERS

are specially designed for leveling the various widths and thicknesses of all kinds of material.



Improved Heavy Type 2-Hi Plate Levelers

Individual top roll adjustment, stationary lower rolls, accurate dial roll settings.

We also specialize in the following equipment—

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Tube Mills

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Draw-Benches, for Bars and Tubes

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Cold Rolled Forming Machinery

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Hardened Steel Rolls

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Hot and Cold Leveling Group

2-Hi levelers ready for shipment to factories, ship yards and reclamation centers.

We solicit your inquiries and will be pleased to submit specifications for the size and type of leveler you need.

The **McKAY MACHINE** *Company*
YOUNGSTOWN, OHIO
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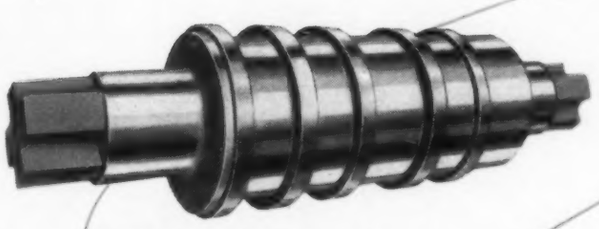
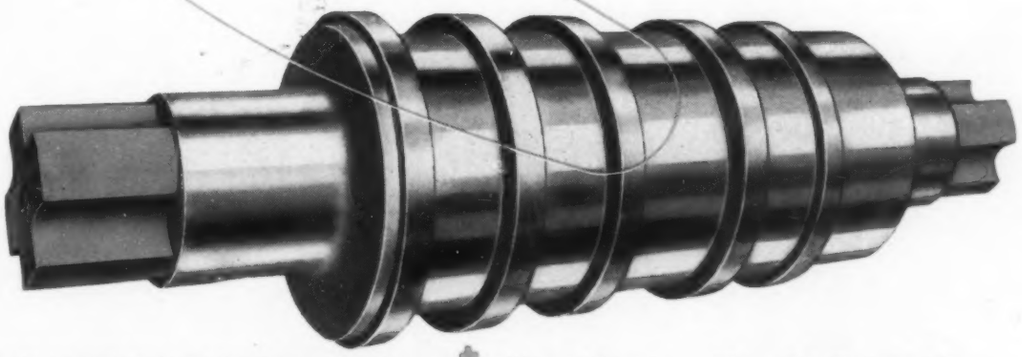
The WEAN ENGINEERING CO., Inc. • WARREN, OHIO

UNITED . . originators of Color Branded Rolls



* "UNEFCO" Chill and Grain . . . *"The Roll with the Green Wabbler"*



The "UNEFCO" GREEN WABBLER ROLL owes its remarkable usefulness to a unique method of manufacture which has defied imitation. It was the first of the serviceable low-phosphorous alloy iron rolls, the first indefinitely chilled roll, and it has remained the most dependable.

Introduced in 1927, and identified then as "The Roll with the Green Wabbler," this UNITED departure gave to industry not only a new knowledge of the chemistry of rolls but a new economy in rolling production and new satisfaction in the range and quality of output.

Unequaled in the uses for which they are recommended, "UNEFCO" GREEN WABBLER ROLLS will continue to afford the user all that advanced research may contribute to the improvement of their quality and performance.

**One of A Complete Line of 15 UNITED ROLLS Individually Color-Branded for Type Designation*

The 15 principal classifications comprising the UNITED ROLL LINE . . . each one a roll type successfully used in modern industry . . . are individually and distinctively *color-branded* to designate *type*, *composition* and *service application*. Roll selection is thereby made easy and accurate.

UNITED ROLLS are the product of advanced metallurgical research and more than 40 years experience in roll design and manufacture.

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

UNEFCO REG. T.M.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

FOR MAXIMUM SAFETY AND CONTINUITY OF SERVICE

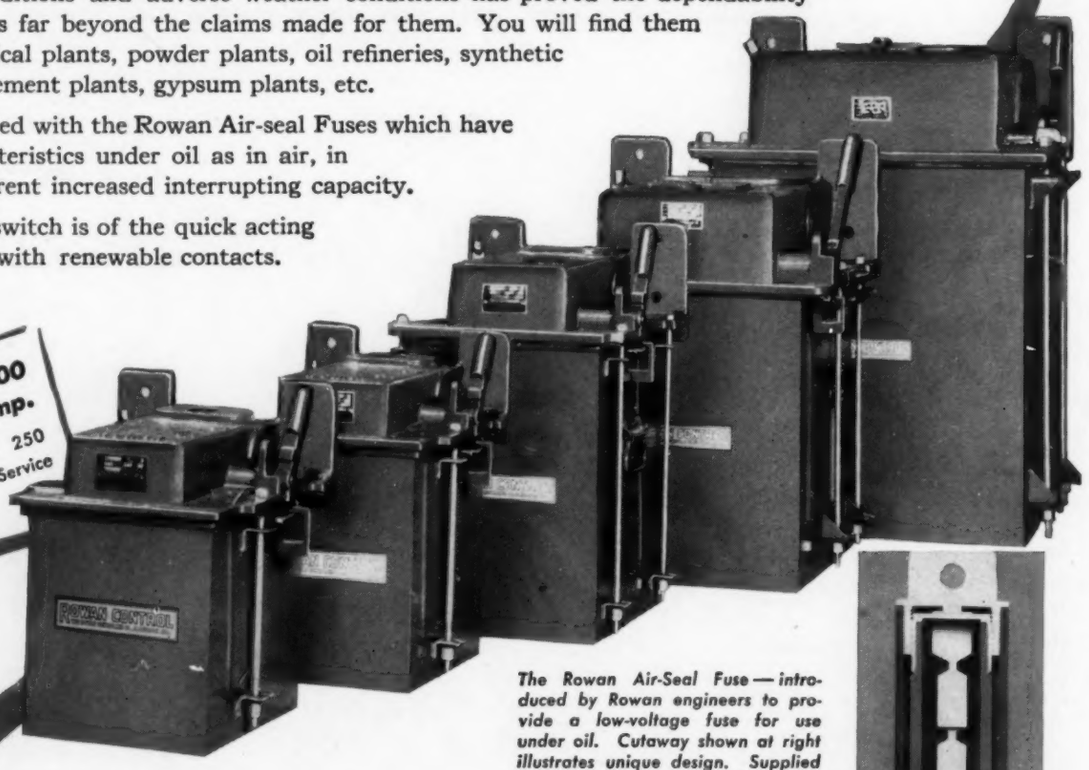
Rowan COMPLETELY OIL IMMERSED, FUSED, SAFETY LINE DISCONNECT SWITCHES

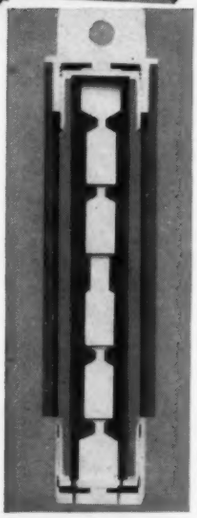
Designed and time-tested for locations where the atmosphere is contaminated with corrosive elements, semi-hazardous and hazardous vapors and dust. Continuity of service under these conditions and adverse weather conditions has proved the dependability of these switches far beyond the claims made for them. You will find them located in chemical plants, powder plants, oil refineries, synthetic rubber plants, cement plants, gypsum plants, etc.

They are equipped with the Rowan Air-seal Fuses which have the same characteristics under oil as in air, in addition to inherent increased interrupting capacity.

The disconnect switch is of the quick acting contactor type with renewable contacts.

30 — 60 — 100
200—400 amp.
Available for 250 and 600 Volt Service





The Rowan Air-Seal Fuse — introduced by Rowan engineers to provide a low-voltage fuse for use under oil. Cutaway shown at right illustrates unique design. Supplied in 30—60—100—200—400 amp., 250 and 600 Volt.

Other features of the Rowan Oil Immersed Disconnect Switch are:

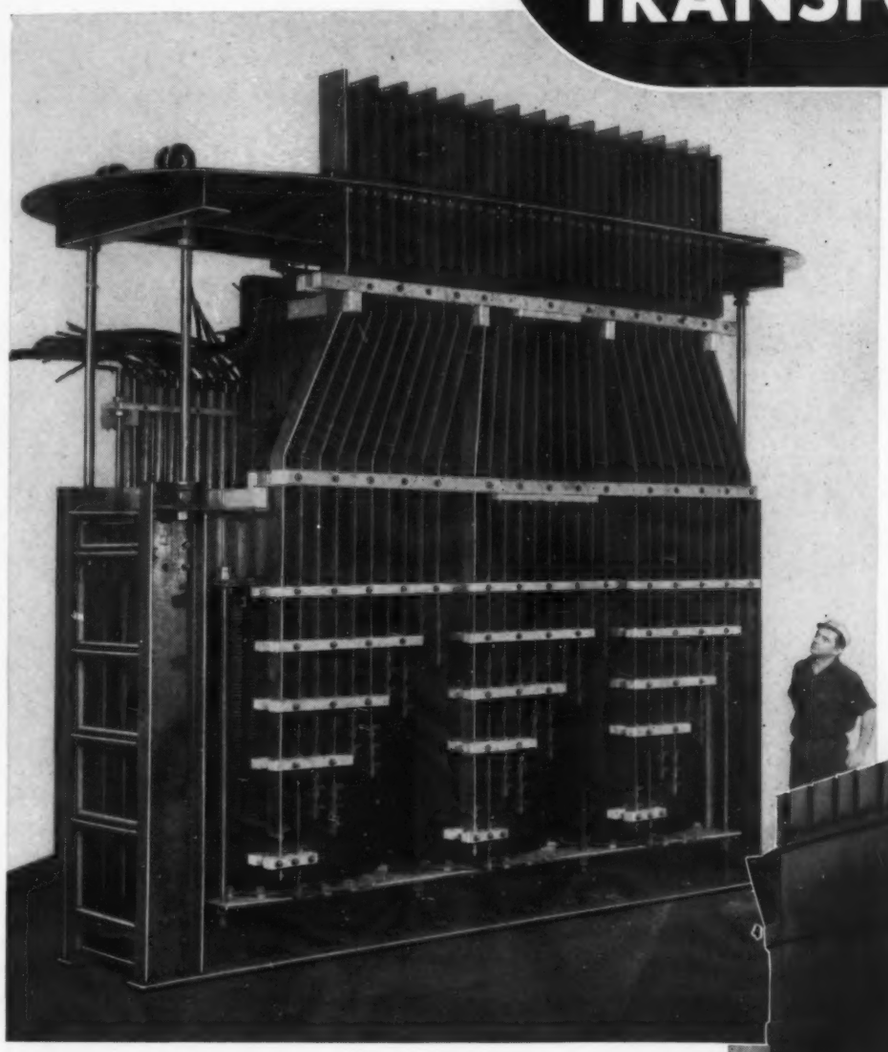
1—ROWAN AIR-SEAL fuses. **2**—Completely oil immersed. **3**—Disconnect switch of the quick acting contactor type with renewable contacts. **4**—Safety enclosing case mechanically interlocked to prevent lowering of tank when switch is in operating position or closing of switch when tank is lowered. **5**—Enclosing case is weather-resisting and dust-tight. **6**—PROVISION for locking disconnect switch in "off" position. **7**—Tank handles for ease of handling.

The Rowan Controller Company has specialized in Oil Immersed Controls for nearly half a century. Results and performance achieved by users justify the Rowan claim of superiority in this field. Write for complete information on Rowan Oil Immersed Controls.

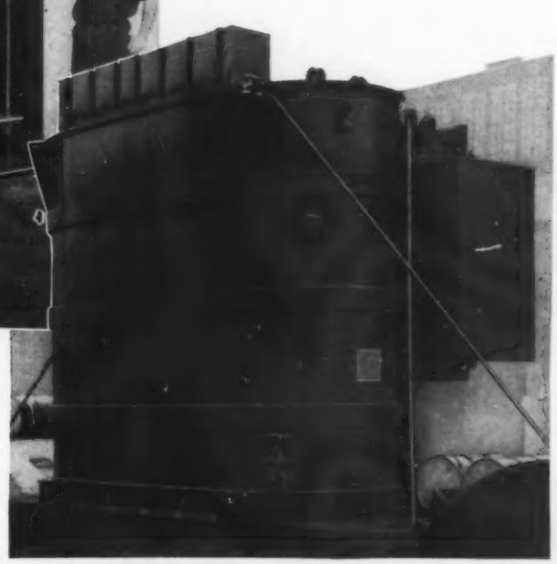
ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Pennsylvania

FURNACE TRANSFORMERS



For over 30 years the designers of Pennsylvania Transformer Company have paced the industry in the development and construction of Electric Furnace Transformers. Many special conditions, not encountered in ordinary transformer design, such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses, have been met by continual research and sound engineering practice. The large number of Pennsylvania Furnace Transformers serving the steel industry today attest to their reliability and efficiency of performance.



Pennsylvania's staff of experienced engineers and the manufacturing facilities of two plants are at your service.

Pennsylvania Transformer Company also builds all sizes and types of power and distribution transformers.

Pennsylvania TRANSFORMER COMPANY

808 Ridge Avenue, N. S., Pittsburgh 12, Pa.

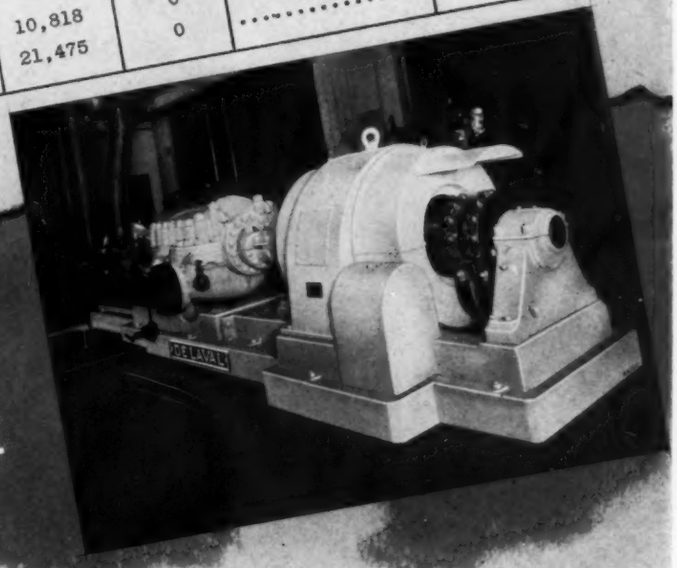
Look at the Record!

SERVICE RECORD—As of September 1, 1944

DE LAVAL PUMPS at _____

No.	Discharge Pressure psig	Suction Temp. °F.	Placed in Service	Total Service Hours	Outages Due to Pump	Cause of Outages	Approx. % Increase in Pump Power
14	1186	260°	12- 2-38	40,383	2	Replace ball locating bearing and shaft sleeves	Negligible
					1	Replace shaft sleeves	Negligible
15	1186	260°	10-11-40	28,839	0	.....	5%
21	1186	350°	8- 4-39	10,818	0	.....	
16	1186	260°	1- 2-42	21,475			

Capacity (all units).....1455 g.p.m.



of DE LAVAL HIGH-PRESSURE BOILER-FEED PUMP PERFORMANCE

Not one major trouble after as much as 40,000 hours of service!

The first of these units was installed in February, 1938; the most recent in February, 1942. All have demonstrated the satisfactory performance of De Laval boiler-feed pumps for high-pressure central station service.

Other important installations, operating at pressures up to 1600 psi and handling high temperature feed water, are operating with equal freedom from trouble, due in no small measure to the excellent performance of the De Laval automatic balancing device, the De Laval large clearance labyrinth wearing rings, and the sturdiness of De Laval solid end head construction.

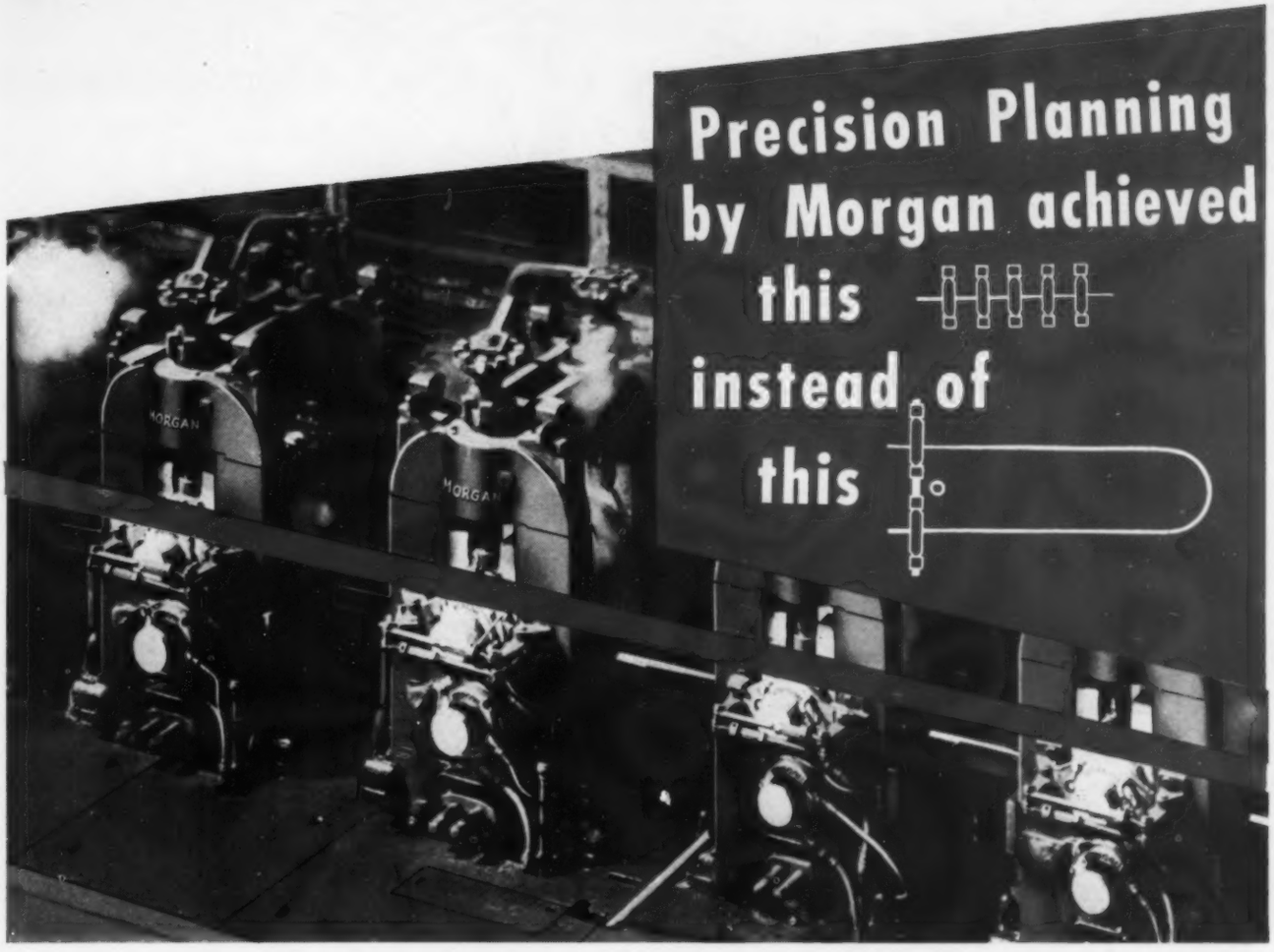
3629

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG



Straight Line Production marked the Turning Point in Rolling Mill Design . . .

In 1888, Charles Hill Morgan designed and built a rolling mill that marked a turning point in the steel industry. Roll Stands were arranged in *tandem* formation instead of end to end, and the steel passed directly from one set of rolls to the next.

The basic idea of continuous rolling was not new but its successful application lay in Morgan's *precision planning.*

A continuous mill is a mass producer, but is never mass produced. Every detail must be worked out on paper — to meet the demands of site, existing equipment, tonnage and variety of product.

Morgan equipment has been *Precision Planned* for more than 50 years. That is why Morgan Mills get under way quickly, shoulder peak production, and are functioning satisfactorily after more than 10 — 20 — 40 years . . .

English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England

MORGAN CONSTRUCTION CO.

WORCESTER • MASSACHUSETTS

ENGINEERS AND BUILDERS OF ROLLING MILLS • WIRE MILLS
REGENERATIVE FURNACE CONTROLS • GAS PRODUCERS

United 27" x 53" x 98" Hot Strip Mill

Designing and building rolling mills and rolling mill machinery has been our business for over 40 years.

Plans for modernization of present facilities, or for the creation of totally new processes and equipment for rolling ferrous, non-ferrous or even non-metallic materials, should be discussed with UNITED engineers. Our intimate knowledge of the rolling industry, and the productive capacities of our six great manufacturing organizations, are ready to serve you.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

All operating functions, including adjustable-speeds are provided from plant's A-c. circuit on this Waterbury-Farrel Wire Draw Bench by a 5 Hp. Reliance V★S Drive.

In the North Chicago plant of the Fansteel Metallurgical Corporation there is a draw bench which processes wire for many unusual purposes from such "story book" metals as tantalum, tungsten and molybdenum. And, because of the need for widely varied speeds under constant and absolute control, the Reliance V★S Drive has proved a "natural" for these delicate operations.

With V★S—an *all-electric, adjustable-speed drive operating from A-c. circuits*—unlimited speed variation with absolutely smooth acceleration and deceleration and automatic maintenance of proper tension are available. Automatic reversal can be provided at any desired point. Starting, stopping and speed changes are controlled from either nearby or remote stations.

Write for Bulletin 311, or call the nearest Reliance office for information about Reliance V★S Drive which may suggest how you can use it profitably in your own production operations, or in designing new production machinery.

RELIANCE ELECTRIC & ENGINEERING CO.

1084 IVANHOE ROAD • CLEVELAND 10, OHIO

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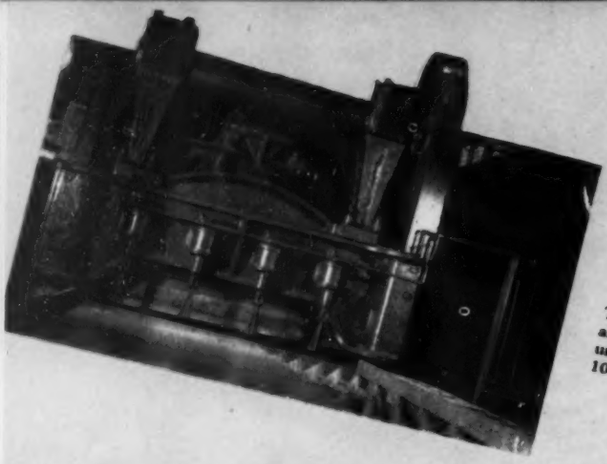
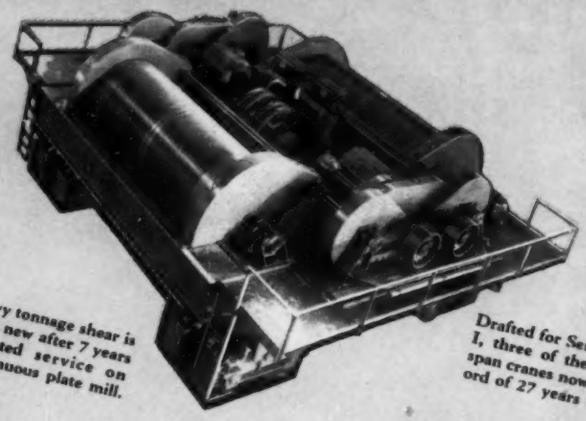
"MOTOR-DRIVE IS MORE THAN POWER"

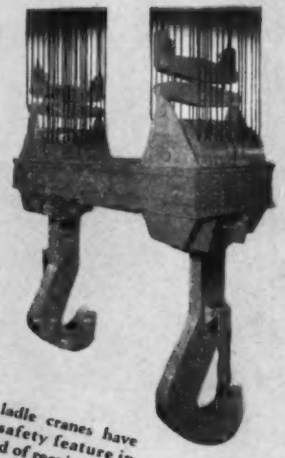


This heavy tonnage shear is as good as new after 7 years uninterrupted service on 100" continuous plate mill.



Drafted for Service in World War I, three of these 336 ton 90' 0" span cranes now have a service record of 27 years without furlough.

World's Largest Builder of the World's Largest Cranes



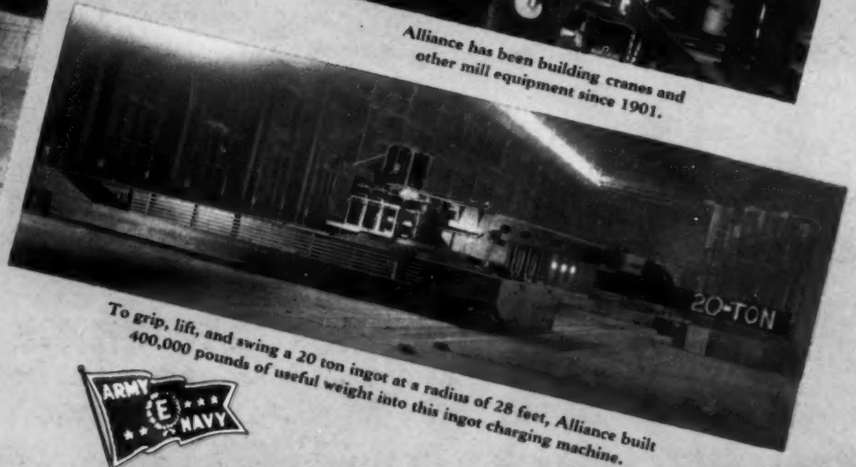
Alliance ladle cranes have an extra safety feature in the method of reeving hoist ropes...an Alliance patent.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES

Sixty ton ingots ride to the plate mill in this giant Alliance Ingot Chariot.

Alliance has been building cranes and other mill equipment since 1901.

n addition to multiple range tongs, there are many nique features on this new type soaking pit crane.



To grip, lift, and swing a 20 ton ingot at a radius of 28 feet, Alliance built 400,000 pounds of useful weight into this ingot charging machine.

ARMY E NAVY

THE ALLIANCE MACHINE CO.

ALLIANCE, OHIO

PITTSBURGH, PA., OFFICE — 1622 OLIVER BLDG.

Alliance

"Here's good news for you, Mr. X"

How bearing maintenance jobs can be made

● SIMPLE ● CLEAN ● FAST ● FEW

G-E Textolite Roll-Neck Bearings offer four individualized benefits to the many Mr. X's in the steel industry—THE MASTER MECHANICS—THE SUPERINTENDENTS OF MAINTENANCE—and the other men with other titles who supervise the repairing and replacing of roll-neck bearings in their mills.

With Textolite bearings, replacements are actually simple. The bearings arrive at your mill "tailor made" to fit the chucks; as soon as the few bolts which hold the old liners in place have been removed, the worn bearings slip out and the new ones are quickly fastened in . . . . It's that simple.

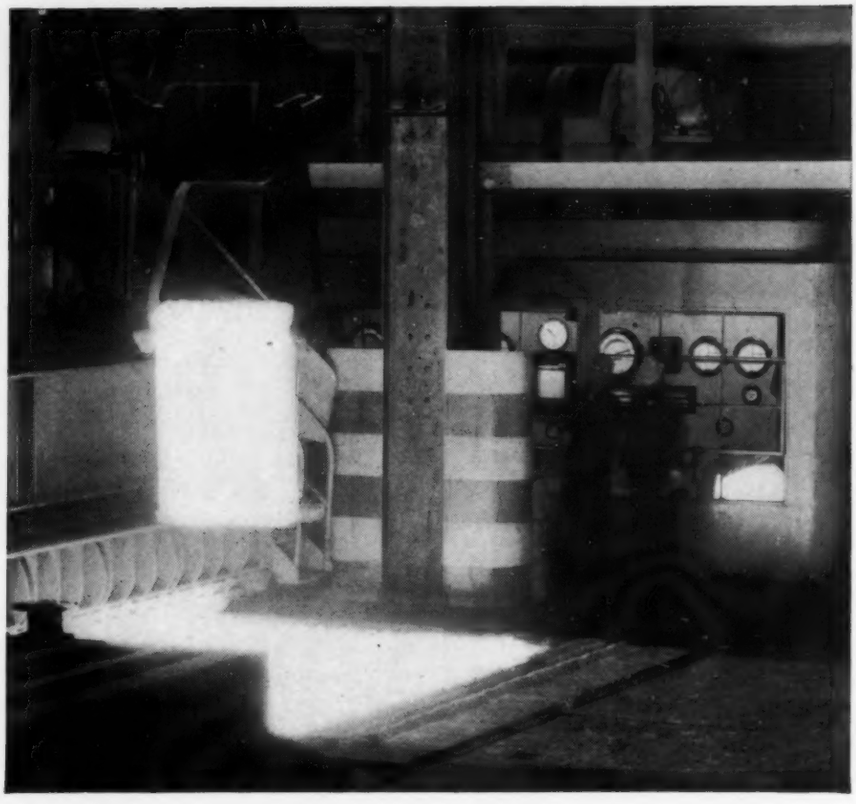
But this operation is also fast and clean. All the work and mess which accompanies metallic bearing maintenance is eliminated—man hours are saved and working conditions are improved. And because Textolite bearings are so tough and long wearing, replacements are comparatively few.

"It will pay both you and your company if you recommend G-E Textolite bearings for your mills, Mr. X, and our experienced bearing engineers are ready to help you make the installations."

For further information write Section W-1, General Electric Company, Plastics Divisions, One Plastics Avenue, Pittsfield, Mass.

CD46-C1

GENERAL ELECTRIC



Ingots from all parts of the pit are alike in temperature, and are evenly heated from top to bottom in the Lukens Steel Company's plant.

INDIVIDUAL Pit Controls Save Time and Fuel for Lukens

Anoutstanding feature of soaking-pit operation in the Lukens Steel Co. plant at Coatesville, Pa., is that each pit has its own separate, individual and *fully automatic* control system! Adapted gradually during years of experience, this completeness of control holds its place by its time- and fuel-saving performance.

Principal feature of the Micromax round-chart temperature controllers is that they regulate the rate of heating. Temperature approaches the end point at a good speed, but does not overshoot, and the operators lift the covers for inspection only at long intervals. Each pit has two burners, with separate fuel-air ratio regulators. The Micromax throttles fuel to these two units, and ratios can be changed at will. Draft gauges show when changes are needed to "balance" the two sides of the furnace. Furnace pressure is automatically controlled, and the temperatures of air and flue gas are automatically recorded by Micromax instruments.

Control panel photographed through cubicle windows. Heater looks at Micromax Recorder for air and gas temperatures; behind him is Micromax Round-Chart Temperature Controller which regulates rate of heating.

These controls, and the recorded information, enable each pit to operate at highest efficiency, regardless of differences in size of charge, condition of burners or any other factor.

The Micromax instruments are described in Catalog N-33B, but if you have a control problem, an L&N engineer will gladly give specific data.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

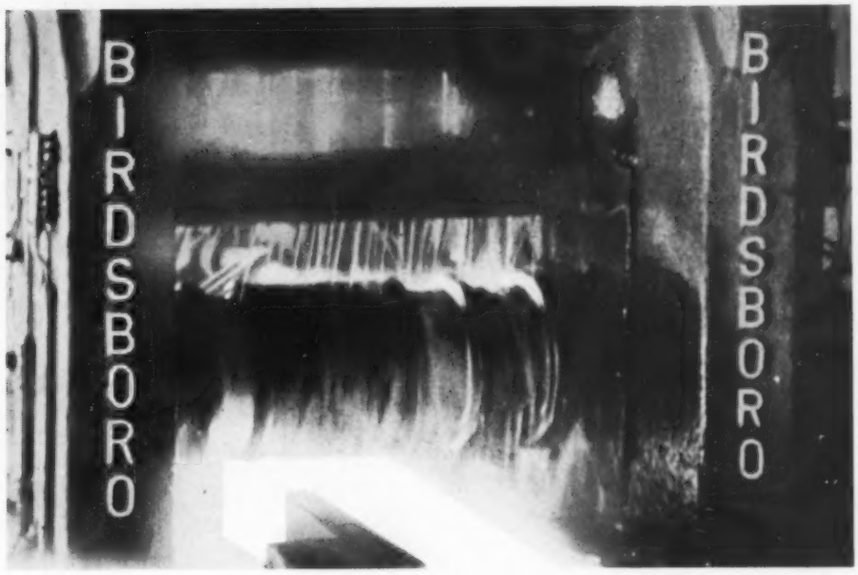
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-00-667(1)

BIRDSBORO'S

Individualized Roll Service

IN ACTION



Birdsboro Rolls at work in a quick reversing 26" Birdsboro Blooming Mill

ACTION . . . the kind required to meet the demands of war-pressed production. SPEEDY ACTION . . . made possible with these Birdsboro Rolls, *individually* designed for use in this Birdsboro Rapid Two-High Reversing Blooming Mill.

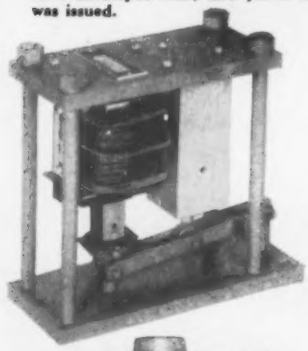
Just the right combination of analysis and physicals were engineered into these rolls to do the job best. That's why Birdsboro Rolls give greater tonnages, more rolling accuracy, longer *uninterrupted* production.

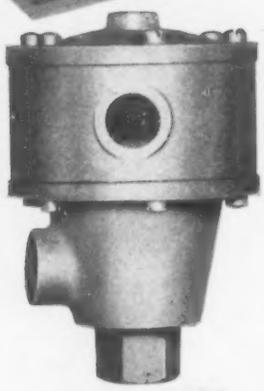
Your individual roll problem will be tackled in just this fashion. Consulting Birdsboro is the wise step to take when you want rolls designed specially for the job.

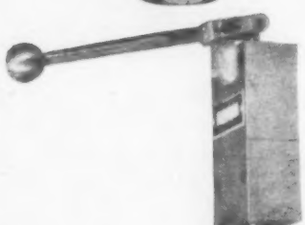
BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY, BIRDSBORO, PA.

BIRDSBORO
ROLLS

If the valve action you want is not shown in the factual, easy-to-use, Quick-As-Wink catalog (copy upon request), write us about your requirements. We have developed many new valves since our catalog was issued.







Quick As Wink

· HUNT CONTROL VALVES ·

QUICK-AS-WINK VALVE CONTROL Makes the Big Difference in Quality of Raw Stock for Tires and Tubes

The rugged and compact Banbury Mixer transposes raw stocks of natural and synthetic rubber, plastics, pigments, etc., into workable material for the production of finished products, such as tires, tubes, linoleum, plastics, paints, etc.

In many Banbury Mixers, such as this one and the other Banburys in the plants of Goodyear Tire & Rubber Company, Akron, Ohio, Quick-As-Wink hand operated, solenoid and diaphragm valves form a combination for achieving time and temperature control of each batch. Neither dust nor dirt can harm Quick-As-Wink diaphragm valves, which are unprotected and located below floor level. They are completely housed. There are twelve Quick-As-Wink control valves in all in this mixer; three hand operated; four solenoid; and five diaphragm.

The Banbury Mixer is only one of many applications where the well-known Quick-As-Wink valves are used to assure positive precision control of air, water, or oil.

C. B. HUNT & SON, Inc.

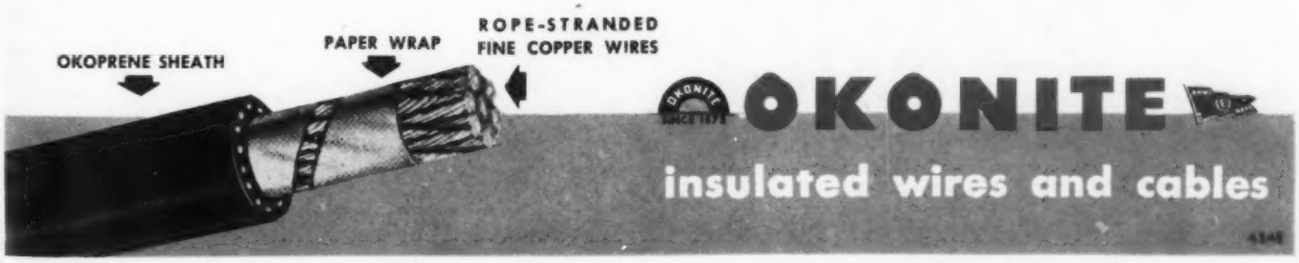
SALEM . . . . . OHIO

OKOCORD is the portable cable you can haul over rough surfaces, twist around corners, use in wet spots. Indoors and out you can use it safely on the jobs that are really punishing. You can feel sure that it has the electrical properties to deliver full power reliably — and the mechanical strength to deliver long service life under severe conditions and external abuse.

Vulcanized in a continuous metal mold, Okocord is tough, highly flexible and does not kink. In the Okocord single conductor electrode-holder cable shown here, fine copper wires are rope-stranded for greater flexibility. They give longer life under flexing because they are (a) stranded together on the Unilay principle developed under wartime secrecy for the U. S. Navy and (b) "lubricated" by Okonite's special treatment.

Like other Okocord designs, cable is protected by a sheath of non-flammable Okoprene, made with neoprene, which is not only resistant to abrasion but also to damage by moisture, by oils and chemicals, and by exposure to sun and weather. Okocord electrode-holder cable is furnished with paper wrap over the conductor leaving it clean for connections and with seine twine cord embedded in the sheath for greater mechanical strength.

Use Okocord also for tools, lamps and machinery as well as drag lines, electric shovels and dredges, rock drills, pit pumps and other portable equipment in voltages from 110 to 35000. Made in all sizes, many types of Okocord are of standard design (Bulletin OK-2011), others are custom-built to meet a specific need. Specify "Okocord" on your next requisition for portable cable. The Okonite Company, Passaic, N. J.



THE INTERNATIONAL NICKEL COMPANY INC., NEW YORK 5, N.Y.
PRESENTS: NICKEL on the BLUE PRINTS OF INDUSTRY
NICKEL
STAINLESS
ALLOY STEELS
ENTRANCE
When at the
METAL CONGRESS
Cleveland, Ohio
FEBRUARY 4-8th, 1946
. . . It will interest you to visit the International Nickel Company's exhibit "Nickel on the Blue Prints of Industry".
The display occupies the stage and an adjoining area of the main floor of the Auditorium.

THE INTERNATIONAL **NICKEL** COMPANY, INCORPORATED • 67 Wall Street, New York 5, N. Y.

Arc Furnace Troubles?—

FAULTY ELECTRODE ACTION HANDICAPS FURNACES—PREVENTS EFFICIENT OPERATION. THE REMEDY IS FAST-ACTING "REGULEX" CONTROL:

☛ "Regulex" rotating control accurately controls electrode position during all the changing conditions of the furnace charge, resulting in greater furnace output per kwh input.

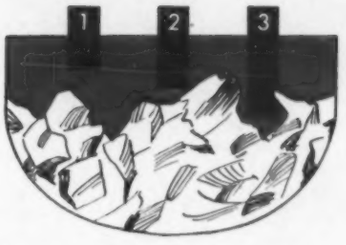
☛ The "Regulex" control system is able to adjust itself instantly to any demand, no matter how small or how large—through sensitive variable-voltage control.

☛ The "Regulex" generator is a sturdy, standard commutator machine, which requires no tricky brush adjustments. Since no springs, levers or contactors are used in the control scheme, maintenance is slashed!

☛ As a unique A-C feature, "Regulex" control can be equipped with flywheels, which automatically raise the electrodes when a-c power fails. The auxiliary generator can make the entire control independent of a d-c shop source when desired.

☛ Your arc furnace manufacturer will be glad to tell you about "Regulex" control for new or existing furnaces. Or write directly to ALLIS-CHALMERS, MILWAUKEE 1, WIS.

Six Conditions "Regulex" Corrects by Fast Action

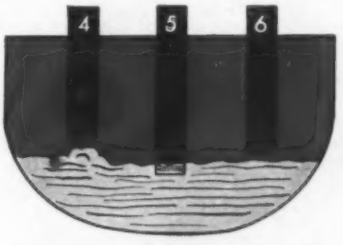


MELTDOWN PERIOD

1. **REPEATED ARC INTERRUPTIONS,** due to sudden "settling" of metal. Sensitive "Regulex" generators reduce arc restrikes—thus meltdown time—by continuous, accurate adjustments.

2. **INSTABILITY OF ARC,** due to inaccuracy of control for raising electrode when short circuit occurs. "Regulex" variable voltage control raises electrodes *just the right amount*—keeps arc values constant.

3. **BREAKAGE OF ELECTRODES,** caused by caving in of metal charge against electrodes. Fast-acting "Regulex" control pulls electrodes safely out of a cave-in. "Regulex" generators also conserve electrodes by reducing number of arc restrikes—thus limiting mechanical shock to electrodes.



REFINING PERIOD

4. **WASTE OF POWER,** as a result of current surges when metal boils up against electrodes. "Regulex" variable voltage control raises electrodes with acceleration directly proportional to amount that arc current and voltage deviate from normal values . . . lower power input results.

5. **FREEZING OF ELECTRODES** in molten bath, due to electrode "drift" when a-c power fails. Only the "Regulex" generator set is provided with a flywheel for automatically raising electrodes upon a power failure . . . preventing electrode breakage, and carbon contamination of the molten metal charge.

6. **BURNING OF ELECTRODES** during refining period, because of using too short an arc. Accurate "Regulex" control permits use of longer arc—conserves your arc furnace electrodes.

Allis-Chalmers

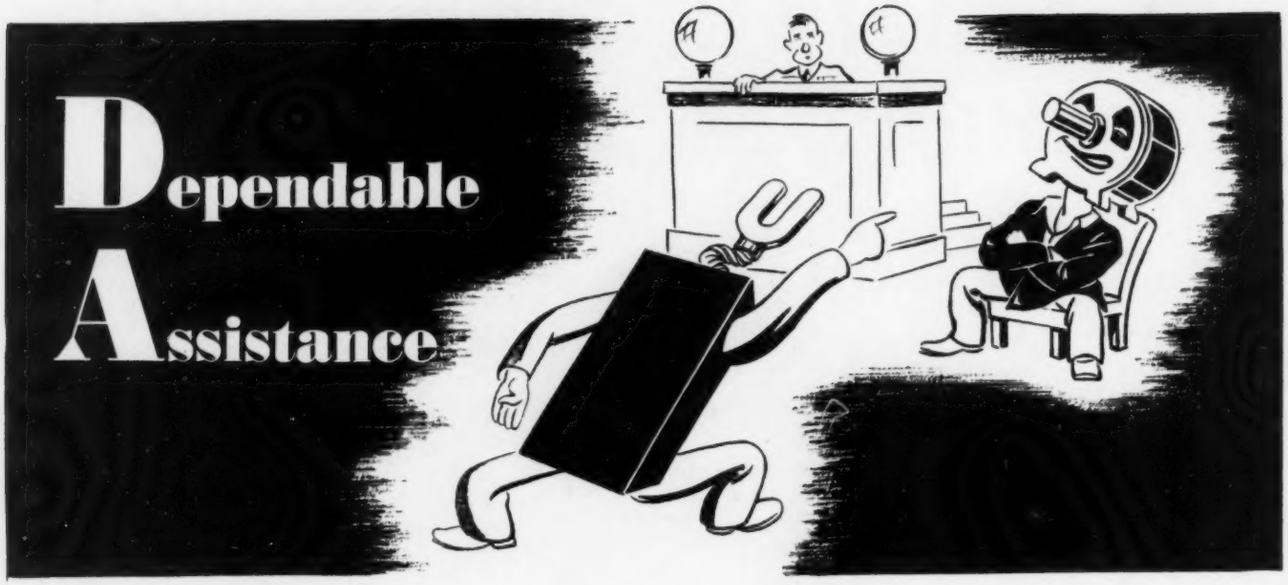
"REGULEX"

Arc Furnace Control

A 1939

HEAR THE BOSTON SYMPHONY: *Every Saturday Evening, American Broadcasting Co.*

Call on SPEER for



. . . make misbehaving motors serve full time

Got a d-c or slip-ring motor or generator that "acts up" . . . that sparks, overheats, burns brushes or wears them out too fast? Maybe the brushes are "misfits."

SPEER can assist you in getting such commutating equipment back to full-time efficiency—for SPEER has made a specialty of matching brushes to machines—mechanically and electrically—for almost fifty years.

That's why you can depend on SPEER brushes for utmost freedom from excessive wear and energy losses and other brush troubles that decrease operating efficiency, cause extra maintenance.

Save time. Make *sure* your brushes are matched to your machines. Make SPEER your headquarters for brushes and brush information. From its all-inclusive line of standard and special carbon, graphite, electro-graphite, and metal-graphite brushes, SPEER can supply the grade that will deliver peak performance, with fewer brush renewals and less maintenance, on any commutating equipment.

Write for Brush Data Forms.

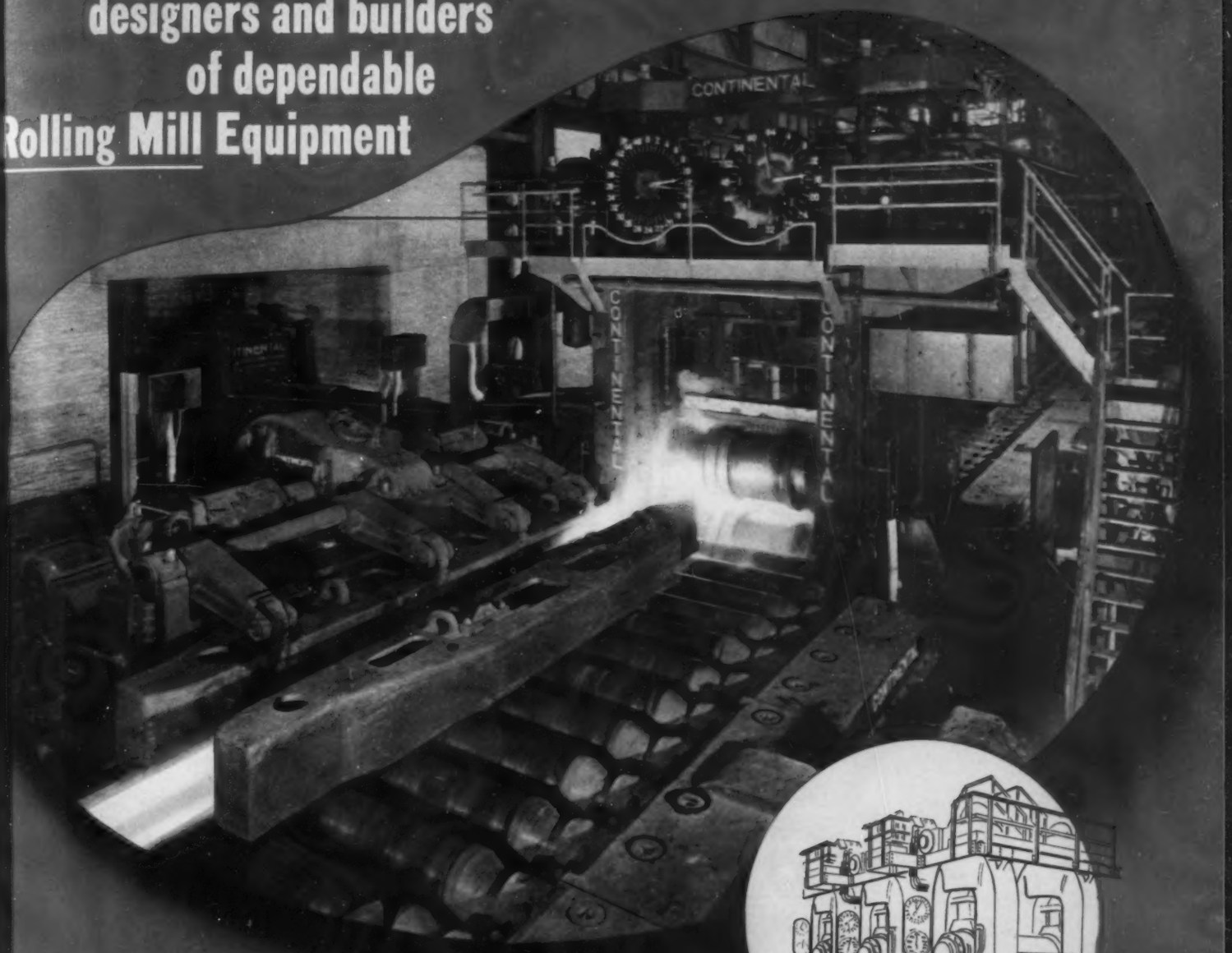
CHICAGO • CLEVELAND • DETROIT
MILWAUKEE • NEW YORK • PITTSBURGH

SPEER
CARBON COMPANY
ST. MARYS, PA.

593

Continental

designers and builders of dependable Rolling Mill Equipment



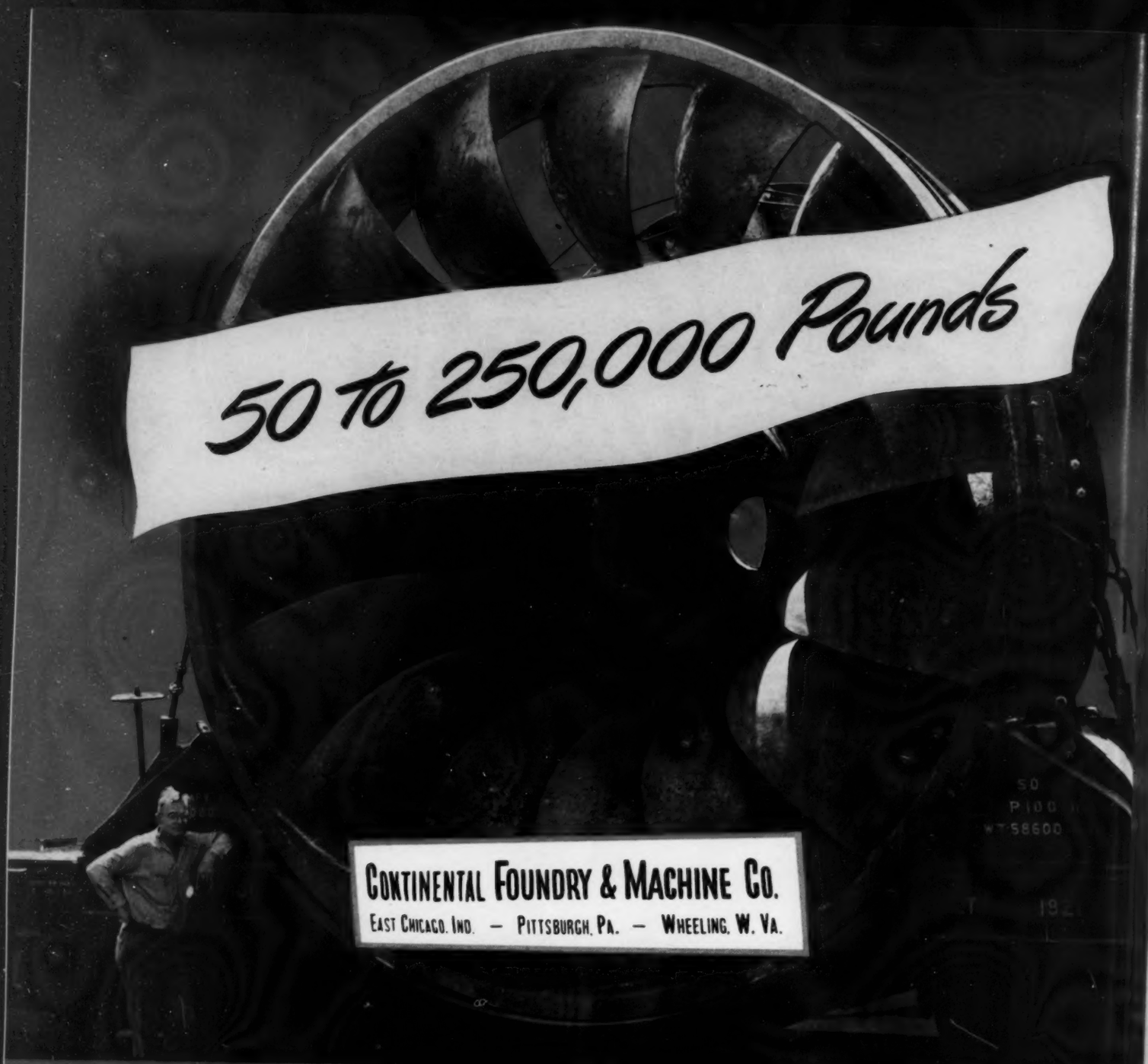
Backed by many years of advanced engineering technique gained through close association and long experience with Rolling Mill operations, CONTINENTAL is admirably situated to design and build *your* standard or special equipment requirements.

Let CONTINENTAL Engineers work with you in 1946 and every year.

Continental

Foundry & Machine Co.

PITTSBURGH • CHICAGO



Continental

Precision Castings

. . . unexcelled facilities for the precision production and finishing of unusual or difficult carbon or alloy steel castings.

Engineering

CONTINENTAL . . . engineers are always available for consultation.

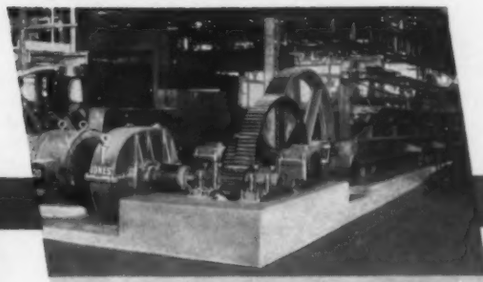
Continental

FOUNDRY & MACHINE CO.

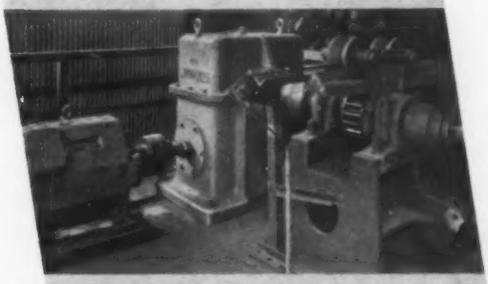
Pittsburgh · Chicago

KEEP GOING

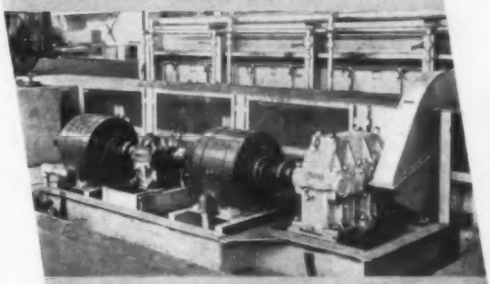
. . . WITH JONES



Jones Herringbone Speed Reducer driving steel tube mill draw bench. Gear casings removed to show proportions of spur gear drive to head shaft.



Jones Worm Gear Speed Reducer operating cover of warming pit in steel mill.



Jones Herringbone Reducers operating furnace in steel mill. Drive consists of two motors with single type and double type reducers coupled in series in order to obtain two widely varying speeds.

Two of a battery of 10 Jones Worm Gear Door Hoists for operating open hearth furnace doors.

Jones Herringbone Reducer operating sheet mill tilting drive on feeder table.

- In every phase of the steel business today, whether it is production or fabrication, the cry is "keep going".

The Jones organization, too, is busy manufacturing the various types of speed reducers and other transmission products that are so essential for drives in every type of plant — drives that are so necessary in maintaining peak production.

We picture here some typical Jones drives that have seen years of service in the steel industry. They have been called upon to take a lot of punishment and they will stand the gaff for a good many years to come.

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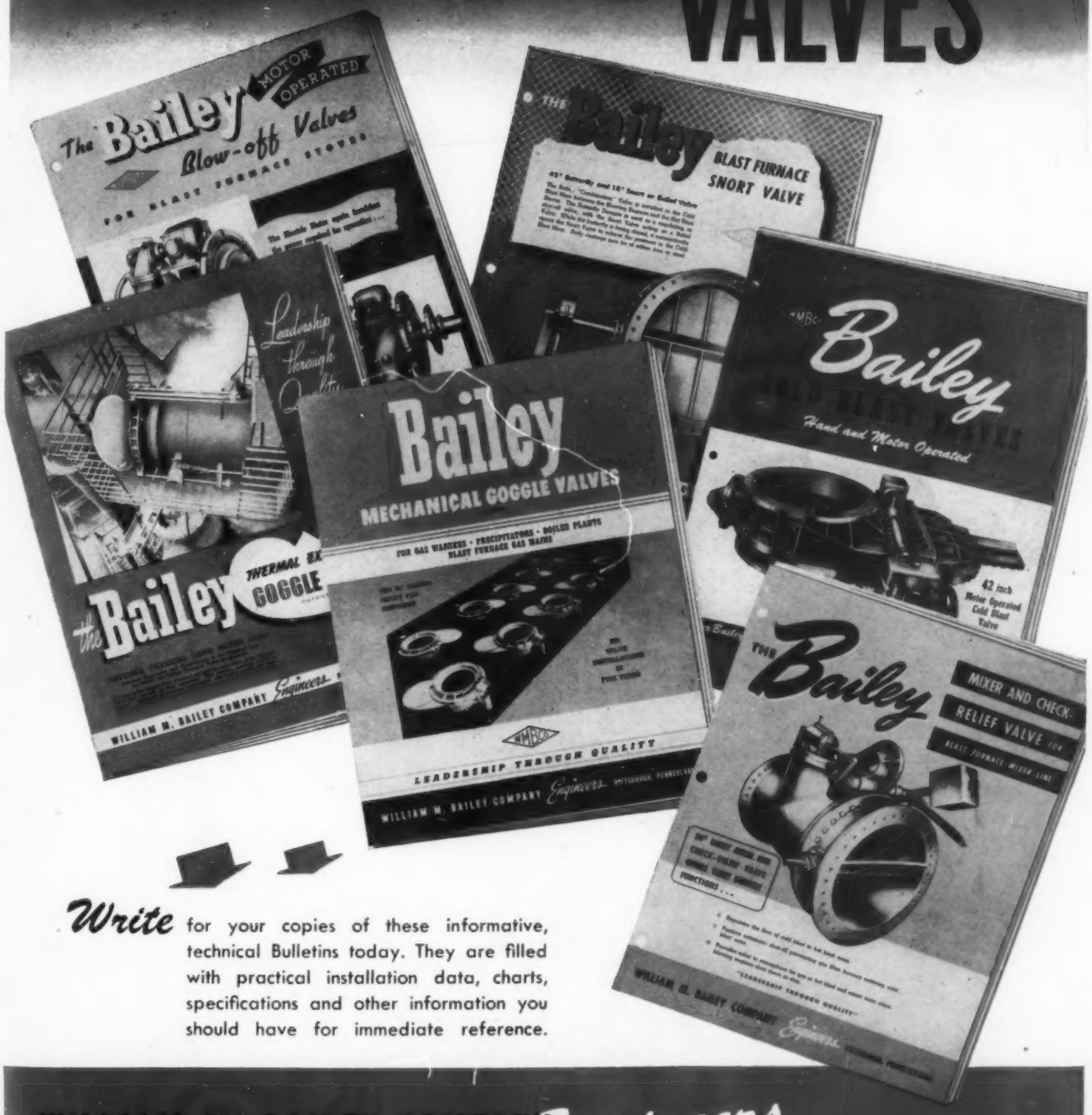
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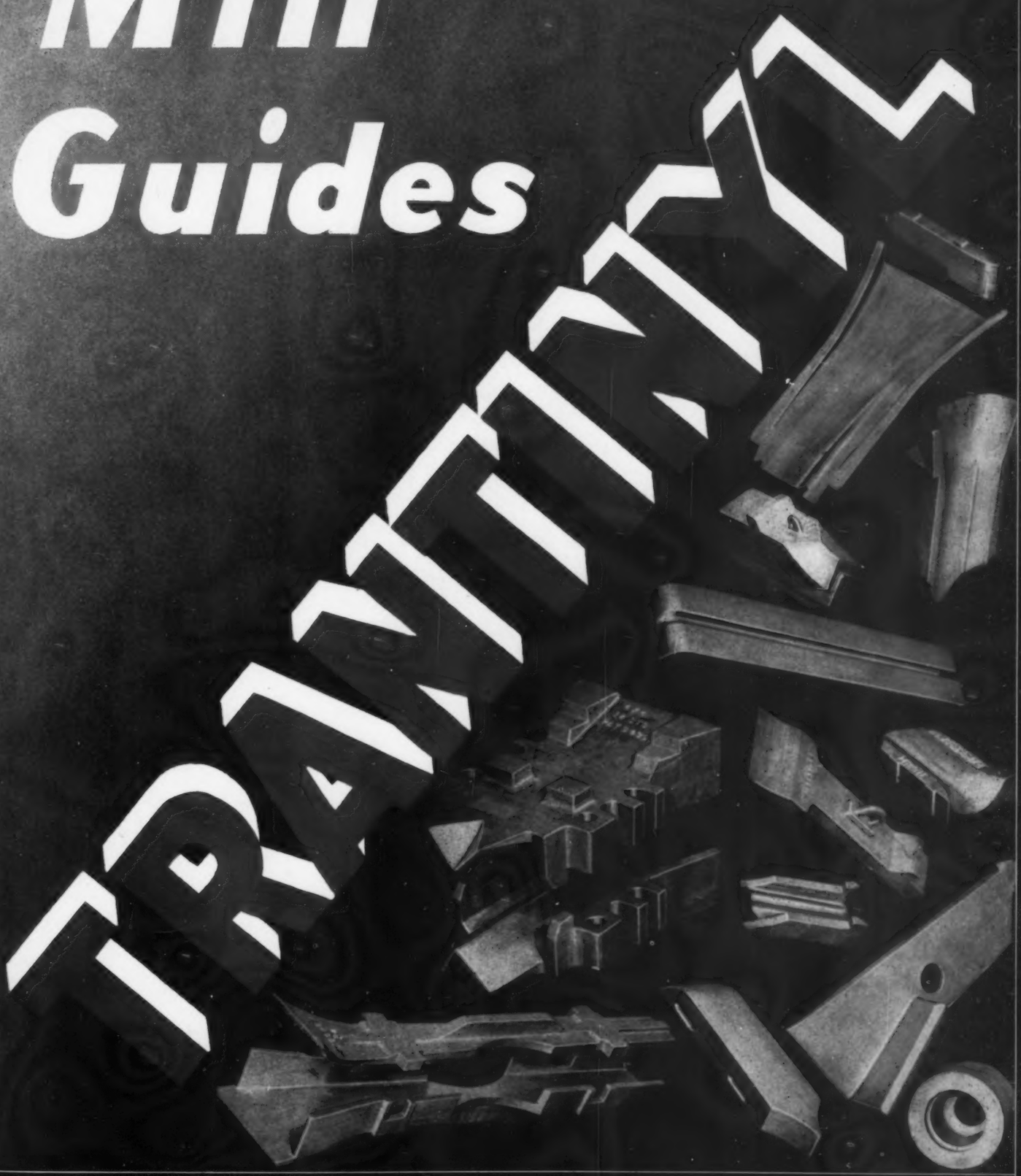

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Youngstown, Ohio

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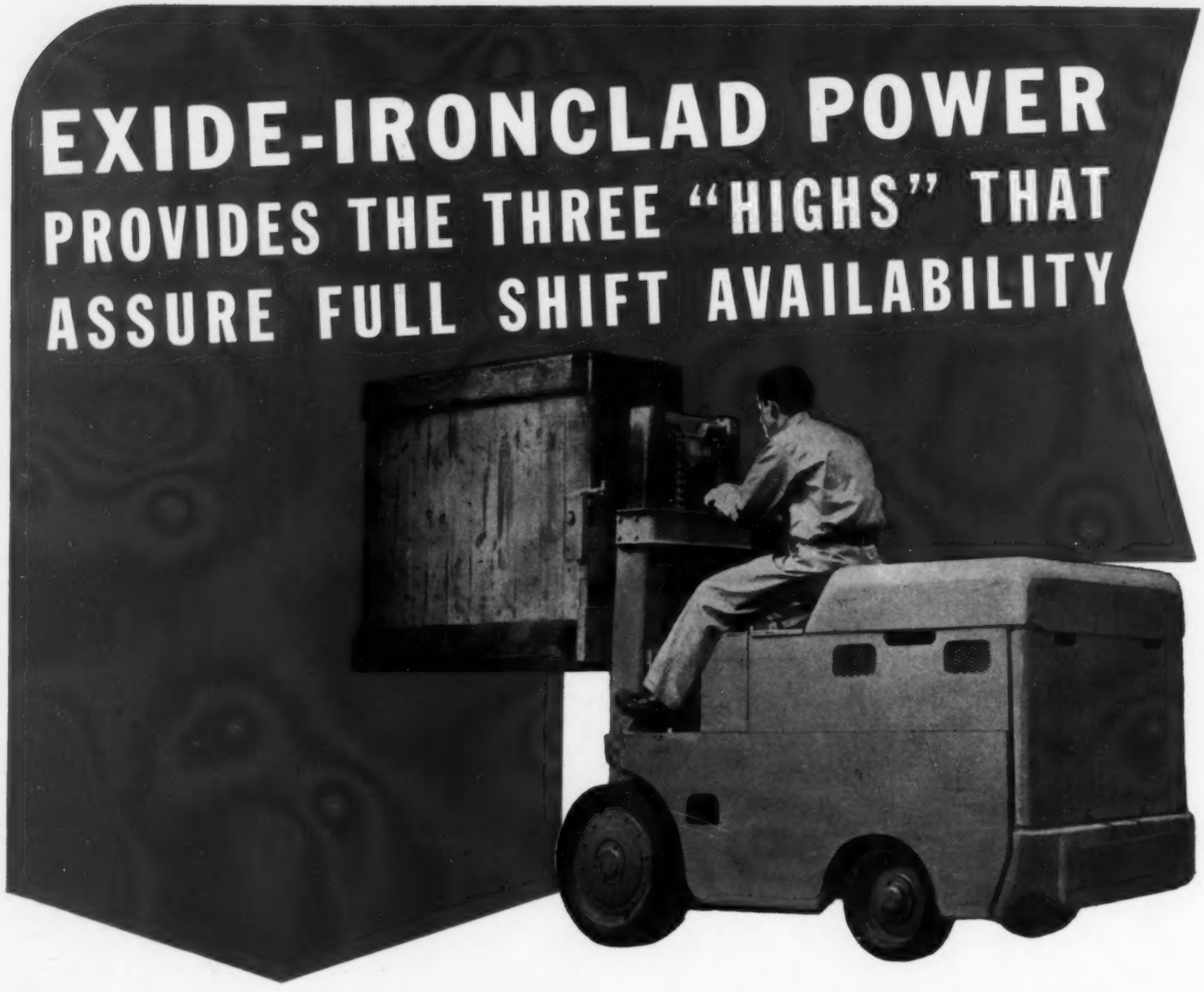

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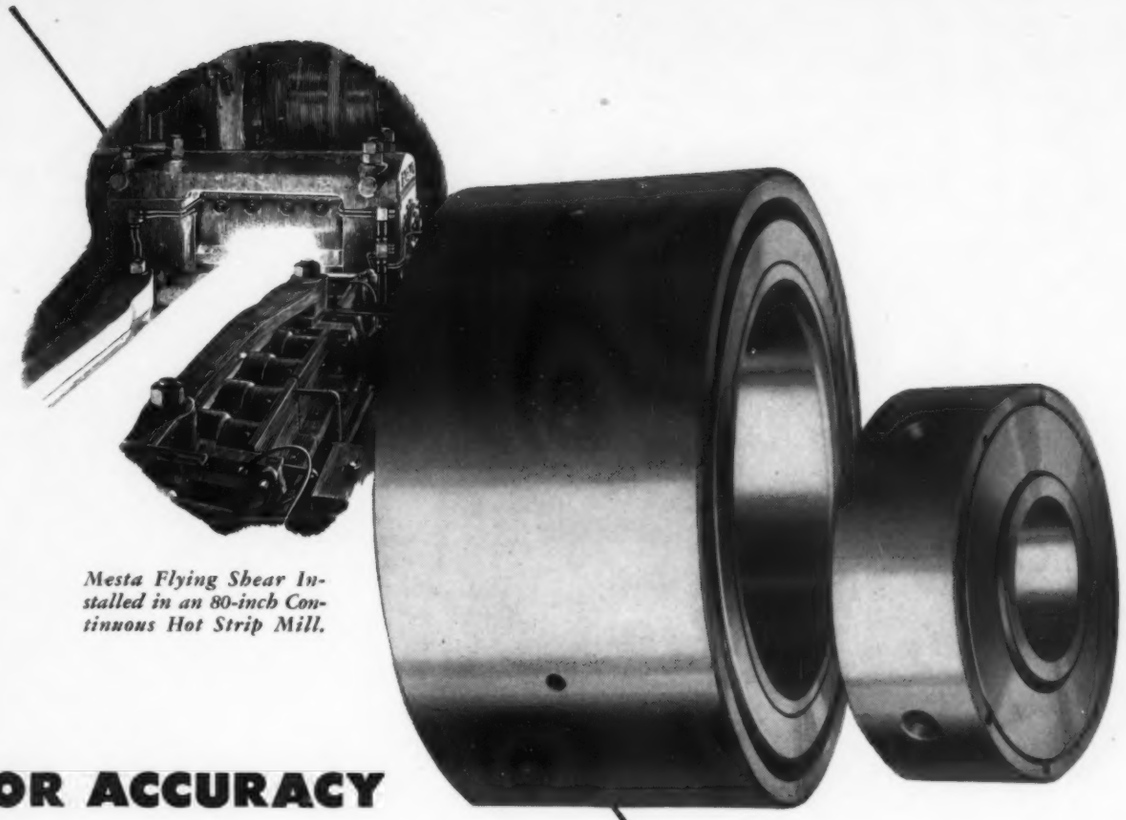
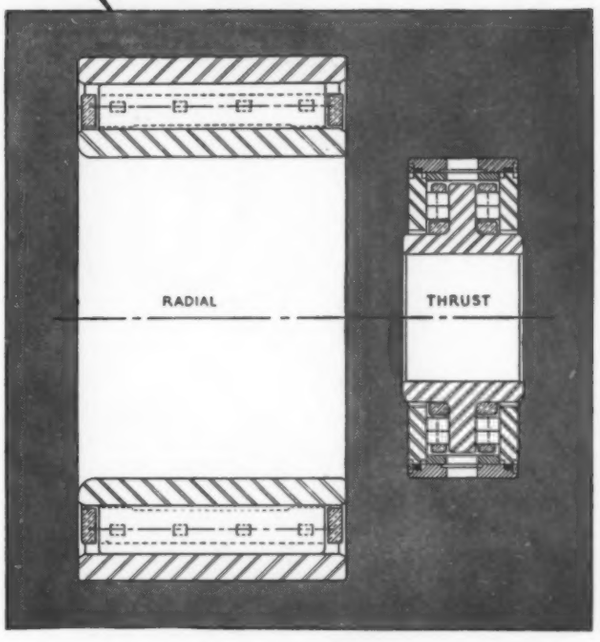


Mesta Flying Shear Installed in an 80-inch Continuous Hot Strip Mill.

FOR ACCURACY IN SHEARING

The flying shear of this continuous hot strip mill entrusts its heavy operating loads to Torrington Roller Bearings. Built to take the around-the-clock punishment imposed by the high speed operation of this modern strip steel cutter, these high capacity bearings provide the necessary accuracy in shearing so that edges are clean and lengths are cut within specified tolerances.

Today, Torrington Bearings are helping to ease the work of many types of steel mill equipment in roughing breakdown mills, rolling mills and continuous hot strip mills. The broad experience of Torrington engineers is available in designing and manufacturing bearings "tailored" to fit your specific requirements.



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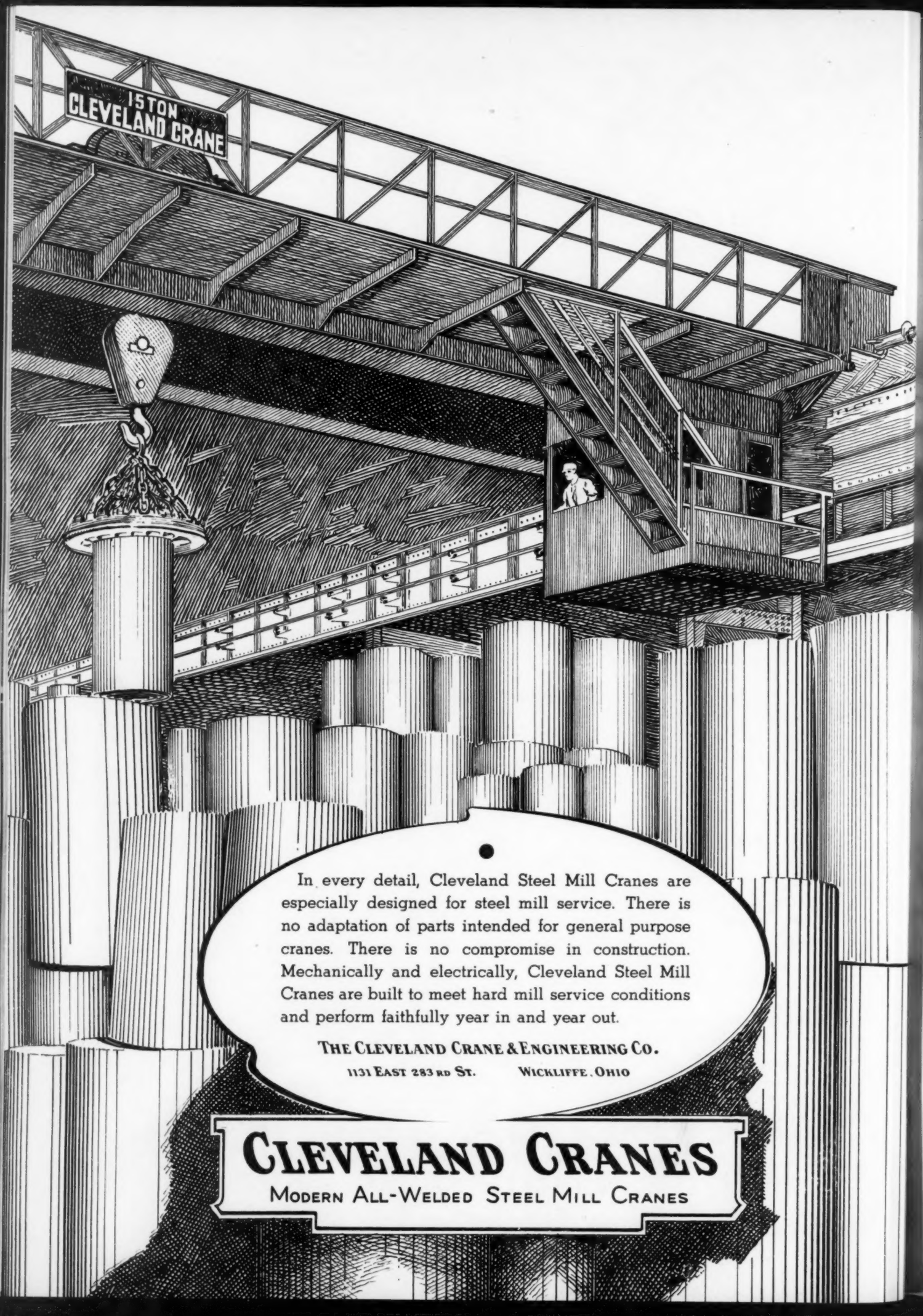
TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL



In every detail, Cleveland Steel Mill Cranes are especially designed for steel mill service. There is no adaptation of parts intended for general purpose cranes. There is no compromise in construction. Mechanically and electrically, Cleveland Steel Mill Cranes are built to meet hard mill service conditions and perform faithfully year in and year out.

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CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

IN his year-end statement, William P. Witherow, president of Blaw-Knox Company, observes that machines have reconverted, but men have not. Technically, the nation is virtually ready for a tremendous upswing of peacetime production, but we do not seem to be emotionally ready as a people. There is too much pressing for personal and group advantages to avail ourselves of this broad national opportunity.

From Pearl Harbor investigation to wage and price questions, we are fighting yesterday's wars and arguments instead of tackling the new jobs at hand. Instead of making goods, we are making "cases." Production for all, not political pressure or group bargaining for some, is still our biggest and most important function.

▲

ALTHOUGH it probably isn't very sporting to wish misfortune upon a good friend and ally, we can't help wishing that, as long as the CIO United Auto Workers wanted to appeal to Prime Minister Clement Attlee of Great Britain to support the union's bid for a 30 per cent wage boost from General Motors Corporation, they would take their strike to England, too.

▲

THE use of "ability to pay" as a yard-stick in determining wage increases presents a definite penalty on good management and would also violate the basic union principle of equal pay for equal work. We can't imagine unions agreeing to the latter. The whole idea is dangerous and well merits the resistance given to it by General Motors.

▲

TECHNICAL information on German industrial processes is beginning to be available to the public through the Office of the Publication Board, U. S. Department of Commerce. Report No. 351 (multilithed, 28 pages) describes the production of hard cemented carbides by a subsidiary of an Austrian steel corporation, Gebrueder Bohler, A. G., at Buderich, Germany.

▲

ONE industrial tool discovered in use in Germany is a machine known as a "coal planer." It is designed to eliminate the normal cutting, drilling, blasting and loading operations, and contributed greatly to Germany's coal production during the war.

▲

CHESTER BOWLES, OPA chief, says shirt makers are holding back production in order to reap a harvest with repeal of excess profits tax on January 1. If they don't soon produce, we won't have a shirt for the collector to take, come income tax day.

Sometime ago President Truman intimated that his white shirts were wearing out, and was consequently deluged with white shirts. Of course we don't expect a deluge, but the size is 15½-34.

▲

EXPERTS say that atomic energy might economically come into competition with coal at $15.00 a ton in 3 to 25 years. Based on present coal prices and reserves, however, this period of time will probably be much greater.

▲

CONDUCTED by the Acid Open Hearth Research Association, a survey of acid open hearth tonnages shows a total of 2,107,493 tons from 40 producers during 1944. This was divided 51.85 per cent to ingots and 48.15 per cent to castings, and materially exceeds the figure of 1,559,860 tons tabulated by the American Iron and Steel Institute.

▲

A RADIO noise filter, said to eliminate static or noises originating in electrical equipment, is a result of wartime development. If they can just revamp it to eliminate those "gooey" commercials, they've got a fortune.

▲

VISITORS always make us happy — some when they come and some when they go.

▲

AUSTRALIAN steel capacity will get a boost from a $22,400,000 expansion program planned by one company. The project includes a merchant mill, coke ovens, ore boats, ore extraction plant and coal mine improvements.

▲

ACCORDING to what we see in the papers, reconversion is proceeding on schedule, but it would seem that other countries are way ahead of us, if we can judge by department store shelves at Christmas time, which carried "made-in," labels from practically every country except Germany and Japan.

▲

ACCORDING to the Washta Journal, very few if any men or women ever died from overwork. It's what people do when they don't work that makes them sick and others tired.

▲

THE steel industry now has an annual capacity of 95,505,280 tons of ingots, 67,313,890 tons of pig iron and 60,856,040 tons of coke.

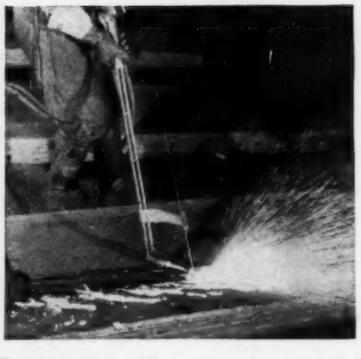
Tough Jobs Made Easy

by LINDE'S Mass Production Methods

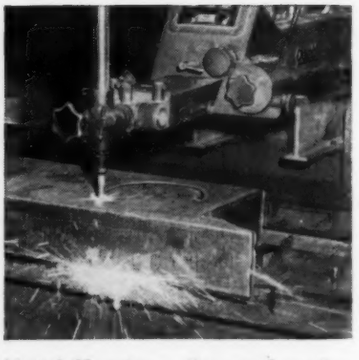
In steel mills, foundries, and metal fabricating shops Linde's oxy-acetylene methods are among today's most efficient mass-production tools. Machines and supplies required for any of these modern metalworking methods . . . plus specialized engineering help . . . are available from Linde. Ask any Linde man for more information.

Ingot-Slitting with an OXWELD C-45, the largest commercial blowpipe in the world, makes slicing through this ingot as easy as it looks. This oxy-acetylene equipment eliminates the need for massive power-consuming machines that would otherwise be necessary.

Steel-Conditioning—LINDE oxy-acetylene hot-scarfing machines installed directly on the roll tables remove surface defects from slabs, blooms, and billets. Higher yields of quality steel are thus obtained faster and without interruption of production.



Deseaming—For secondary steel-conditioning or where mechanized conditioning is not practical, Linde's manually operated scarfing equipment is quick, economical, and effective.



Metal-Shaping—For rapid cutting of simple or intricate shapes, straight-lines, or circles, and for plate-edge preparation on metals of any thickness, a complete line of OXWELD machines is available.

. . . and here are some of them

Removal of Gates and Risers like the large ones on this rudder frame is a speedy operation when done by oxy-acetylene cutting. Here a curved riser-cutting nozzle is being used. For certain castings, mechanized flame-cutting makes it possible to cut several pieces at a time easily, and economically, and with considerable saving in time over previous methods.

Lancing Steel — This oxy-acetylene method saves time in piercing or severing heavy steel sections, and in clearing the tap for the molten metal to pour from the furnace.

Flame-Descaling—This method for removing mill scale and other undesirable encrustations from steel is generally faster and more economical than pickling, sand-blasting, wire-brushing, or grinding.

Gouging—A rapid and economical method of removing controlled amounts of surface metal without affecting adjacent areas. Here you see a shaft end 8 inches in diameter, being grooved to fit a clutch.

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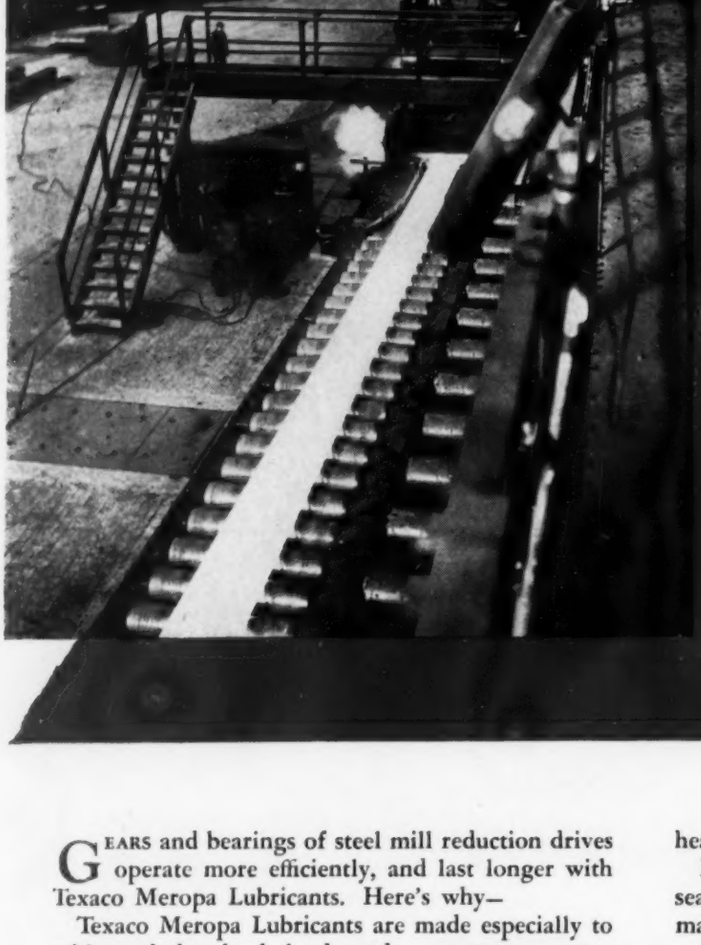

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GEARS and bearings of steel mill reduction drives operate more efficiently, and last longer with Texaco Meropa Lubricants. Here's why—

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Meropa Lubricants were developed by Texaco research, working in cooperation with leading gear manufacturers and steel mill operators. Over the years, Meropa has been steadily improved to keep pace with advances in machinery design, and are available today in a complete line to meet all heavy-duty gear drive requirements. You will find them in service everywhere.

Call freely on Texaco Lubrication Engineering Service. Simply contact the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write: The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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Iron and Steel ENGINEER

JANUARY, 1946 VOL. XXIII NO. 1

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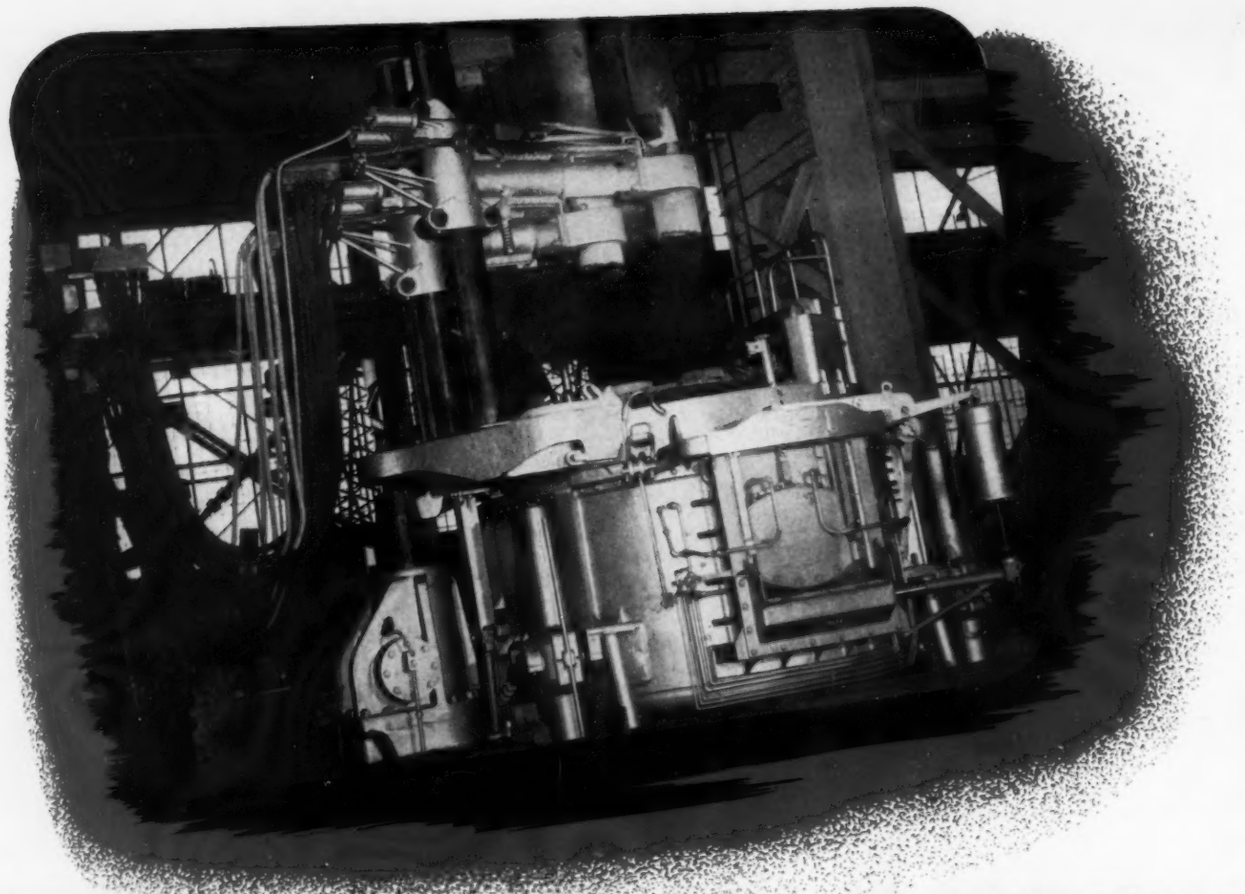

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The Lectromelt Furnace is designed by skilled engineers and practical metallurgists on the basis of broad experience. Experience has taught that simplicity of design, operation, and maintenance are the fundamental qualities of a great electric furnace. In the Lectromelt design all complex operating mechanisms have been minimized. This means ease of operation and low maintenance costs. This attention to fundamentals has resulted in long efficient service with minimum maintenance which characterizes Lectromelt equipment.

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PITTSBURGH 30, PA.

Developments IN THE IRON AND STEEL INDUSTRY DURING *1945*

W. H. Burr
ELECTRICAL SUPERINTENDENT
LUKENS STEEL COMPANY
COATESVILLE, PENNSYLVANIA

. . . . this material was prepared by the A. I. S. E. Development Committee, of which Mr. Burr is chairman . . . .

▲ HUMAN reconversion promises to be a tougher proposition for the steel industry than the actual reconversion of facilities to normal or even abnormal peacetime demands. It seems certain, based on the first few lessons learned in the closing months of 1945, that the most trying problems will be in the industrial relations departments rather than in the operating or engineering division.

There has probably not been a year anywhere in the annals of steel which has provided as many sudden changes in demand as 1945. The accent has been consecutively on heavy steel, bars, sheets, and strip; it has shifted from decreasing military needs to sudden peaks of demand and next into virtually complete cancellations followed by a tremendous civilian demand.

One fact stands out — these sudden swings in demand from one product to another, from heavy backlogs to virtually nothing, have proven the flexibility of plant facilities. Conditions have arisen which first required plate facilities, then bar mills, and finally sheet and strip mills to meet heavy commitments, to which the men and equipment have responded.

This proven flexibility will enable the industry to meet the heavy anticipated needs of peacetime without further expansion in basic facilities. It is undoubtedly true that there will have to be some refinements in the industry's plants. These refinements are already under way — in fact, some have been under way for more than a year. For example, the expansion in cold strip mill facilities, which was overdue at the beginning of the war, has now reached full bloom and there are probably more new cold mill facilities on order and under construction than at any previous period in the history of the industry. This activity reflects the interest of steel buyers in higher quality finish, which also accounts for the activity reported during the year on various types of finishing facilities, notably the electro-deposition type for zinc and tin coating.

There is almost certain to be a considerable amount of face-lifting among the producing plants, for despite the fact they were unable to provide as large a cushion as they might have desired out of operating income during war years, there is still a substantial sum earmarked for necessary plant improvements.

For example one of the larger steel companies is centralizing its bar mills in one area, which will result in a more flexible and efficient operating condition. To improve the quality of the bars, careful attention has

Overall view showing crusher house, conveyor system, delivery bin and clinker dock of expanded slag plant for the manufacture of lightweight aggregate.

been given to good heating, continuous scarfing at the bloom stage, elimination of twists between stands and finally proper cooling and preparation of the billet.

During the past few years, it has become more and more evident that many mills are literally being run off their bearings. Blast furnaces and open hearths are being operated under conditions which in normal times would not have been tolerated. Major repairs have been postponed "until after the war" on many indispensable production units.

That "after the war" is now a reality, and it has been estimated that $200,000,000 will be required to reconvert facilities, plus an even larger sum for repair and rehabilitation of run-down equipment. Plans have been laid during 1945 by all major producers for the revamping of their facilities, in some cases for the enlargement of existing equipment, and also, in a few instances, for the installation of equipment to permit the operating company to enter new product fields.

Certainly one of the wartime developments which is already showing its effect on peacetime markets is the revolution in tubing manufacture and markets. Thin-wall mechanical tubing, electrically welded in a continuous process from strip steel, which has grown from a relatively minor item before the war to a large tonnage proposition, seems certain to grab a larger share of the steel market, and will probably not only displace other types of tubing but other forms of steel as well in light fabricating jobs such as metal furniture, etc.

Operations during 1945, which were practically at capacity during the early months, dropped sharply following VJ-day due to cancellations, and plummeted further during the fall months as a result of labor disputes, both in the industry itself as well as among its customers and among industries upon which it is dependent, notably coal. Total ingot production for the year was substantially below the 1944 record of nearly 90,000,000 tons. First half production, most of which occurred under the stringency of heavy war needs, fell to slightly better than 43,000,000 tons. Under the combined difficulties of war's end, cancellations and labor troubles, the second half failed to match the rate of the first six months, and total production dropped slightly below 80,000,000 tons for the year.

Third and fourth quarter production began to give some indication of what peacetime operating rates might be. Despite the fact that there remained many wartime factors, including a labor shortage and only partial reconversion among steel consumers, the advance orders showed that preliminary guesses of a 75 to 80 per cent operating rate would not be far wrong. This reflects, of course, the lack of demand for heavy plate and structural sections, which in wartime went into ship construction and armor plate. It is more than ever obvious that the nation's sheet capacity, instead of being over-expanded as had been thought by some groups before the war, is actually going to be extended to its utmost to care for the growing demand for light flat-rolled steel.

BLAST FURNACES

Although much of 1945 saw a real shortage of pig iron, total iron production failed to make 54,000,000 tons compared with 62,000,000 tons in 1944. The primary reason for this situation was labor unrest in the coal industry, which on several occasions brought on a coke shortage and caused the interruptions to blast furnace operations which resulted in the loss of several million tons' production.

The manpower shortage also cut into operations, and prevented utilization of several stacks which might otherwise have been in production. The shortage was not only in blast furnace operators, but also in coke ovens so that there was an inadequate supply during the year to permit operation at some points.

Of considerable interest generally was the decision of Defense Plant Corporation to dispose of several stacks, both old and new, which were built or rehabilitated for its account during the war. Some of these units will

undoubtedly be absorbed by the industry to replace older stacks which are either small or high-cost units.

More evidence in the case of the dry blast was piled up during the year. With about 20 stacks now equipped, it is becoming increasingly evident that it is a question of operating technique whether such installations will pay off or not. Five units out of the 20 have been reported eminently successful, giving either a higher yield or lower coke consumption or both. The remaining fifteen have been only partially successful, due in large measure to operating difficulties which could be traced to inexperienced manpower and mechanical failures. The argument between high and low moisture content is still unsettled, although the principle of moisture control is pretty well accepted.

Some interest is being shown in the use of anthracite coal instead of coke in the blast furnace. Reports from abroad indicate that successful operation of large furnaces on anthracite is possible, although no tests have yet been made in this country. Use of anthracite died many years ago and little research has been carried on in this connection.

Ore blending plants continued to demonstrate their benefits during 1945, and it is probable that more units will be installed in the near future. The good results on ore have led to some study of the problem in connection with coking coals and limestone, with the possibility that all blast furnace materials may eventually be blended before use.

Despite trends toward poorer quality in raw materials, the accent continues to be on higher quality iron, as indicated by the continued movement toward higher blast furnace hearth temperatures and low sulphur iron. The use of steam as a blast additive has become standard practice at some plants, with good results reported.

Research on ore beneficiation has continued at top speed. Despite the end of the war and the end of its pressure for production, the ore beneficiation picture remains important. Chemical flotation processes seem to have the center of the stage at the moment, although no possible angle is being overlooked. A by-product of the ore situation is the development of hitherto unused ore bodies, such as that at Steep Rock Lake in Canada. There has also been a considerable amount of prospecting in regions of Canada where ore bodies have been rumored to exist but have never been surveyed geologically. Several major bodies of ore have been located and studies are now going forward to determine the extent and quality of the deposits.

By-product coke oven expansion continued during the year, with both underjet type and the conventional models included in new contracts let. It is regarded as virtually certain that the beehive oven will be a museum piece before another year is out. With steel operations at a 70 to 80 per cent level, by-product ovens can supply all the needed coke, and with the possible exception of a few small units, the fires in the Connellsville district will be put out for the last time. Total beehive production during 1945 was only about 60 per cent of 1944 levels, due to a combination of higher by-product output and lower levels of blast furnace operations.

Use of carbon block refractories in the blast furnace seems destined to grow, based on successful results reported by operators of furnaces with carbon block hearths. So far carbon block has been applied only to the hearth and side walls of the crucible in the United States.

STEELMAKING

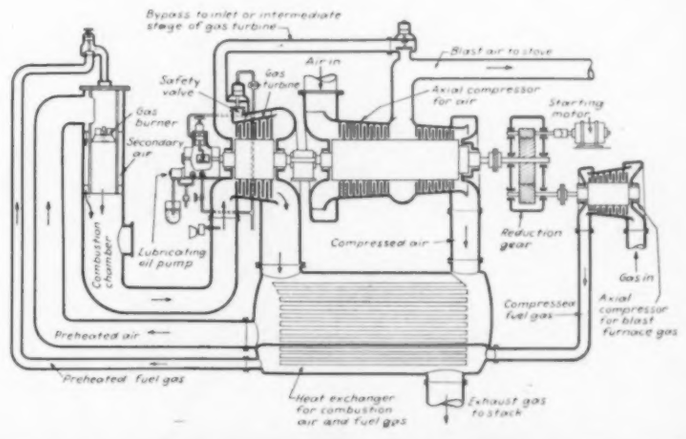
Relationship between open hearth, bessemer and electric furnace steel did not change materially during 1945. There was a continuing drop in demand for alloy steels as compared with the earlier years of the war, but the decline was shared by open hearth and electric furnace alloys alike, with probably a little more of the open hearth tonnage, relatively speaking, losing out.

With the shift from heavier sections to lighter, and the consequent pressure on sheet and strip mill products, the item of scrap contamination became greatly magnified and few plants were free from the so-called "tramp alloys," which gained a free ride into the open hearth via the contaminated scrap route. No effective means of combating this difficulty has yet been found, except the obvious and often quite difficult one of controlling scrap sources on heats where deep drawing quality sheets are to be rolled.

Despite the difficulties in using wartime scrap, report was published during the year covering operation of a small open hearth on an all-scrap charge, using spiegel or high manganese crops to keep sulphur content low. This unit was used in the production of high silicon steels. Successful operation over an extended period was reported on this furnace.

Studies on open hearth slag control have continued, and the possibilities of cleaner, better quality steels from this source seem almost unlimited. Further improvements have been made in hot tops, and experiments in deoxidation are continuing. Results of a research on deoxidation practices as they affect steels destined for high temperature service were published during the year. Discussions are continuing on the relative merits of rimming and killed low carbon steels for both the deep drawing characteristics and the surface qualities required in many postwar applications. The

Gas turbines are receiving considerable attention, although their application to blast furnace blowing, as set forth here, is not seen as an early actuality.



fact that rimmed steels tend to age hardening may result in a trend toward killed steels for structural steel and rails.

The accent on quality steels for postwar application has brought about considerable research, one of the most important of these deals with pouring pit practice and mold conditions. Probably no other place in the steelmaking process has research been so thin, and as a result, probably no other similar segment of the operation offers as rich rewards in quality improvement.

The control of quality has been evident throughout the industry during the past year, much of it through process control, but also in a large measure control comes from metallurgical sources. Better equipment has become available for temperature control, through the use of radiant energy measuring devices. All-basic refractories throughout the open hearth have succeeded in producing higher quality steels. Further work on alloy addition agents has been done, and one example of this is the widespread use of the new titanium-bearing sheets for enameling stock. Use tests, now complete, show this new product to be an important addition to the list of flat rolled products, since it is the only available steel which can take a white or finish coat of porcelain enamel without first applying a dark ground coat.

Close control of analysis in melting furnaces, as well as close control of temperatures throughout the melting and pouring process is another factor in the whole picture of higher quality steel through process controls. This is showing up in end products to a greater extent, with far more uniform physical test results being produced now consistently than before the war, or for that matter, even a year ago. Uniformity, that will-of-the-wisp which steel plant operators have been chasing since the beginning of the industry, is considerably closer now than a short time ago.

Steel plant refractories formed the basis of some interesting studies during 1945, as, for example, the all-basic open hearth, which finally made its appearance this year and which may have a marked acceptance in many applications. The use of rammed bottoms seems destined to outlive its primary application as a time-saver during wartime, and take a place as standard practice in many more shops. Rammed mixes also are being more widely accepted as repair media for electric furnace linings.

The use of silica brick is still standard practice, of course, and new production records have been reported on the new higher quality silica brick, particularly in open hearth roofs. Development of better refractory cements for use with these higher quality refractories has also been part of the story on these high tonnage installations. Use of drop sections of silica brick along the open hearth skewback has been found to prolong roof life by minimizing erosion. In this connection, basic brick has been found advantageous in making repairs to front and backwall.

Electric furnace basic linings have been extended, on the average, about 35 per cent through the use of gun-type refractory patches. In addition, it is claimed this method has provided a solution to sectional repair problems which formerly required the furnace to come off production. Roof cooling rings, arches and jambs, and taphole sections have been successfully repaired with this system. Success is due primarily to the ability of the gun to reach formerly inaccessible areas. A larger

DPC facilities are, for the greater part, in regular operation. Their ultimate disposition is as yet generally uncertain.

Tube mills, of which this new seamless unit is typical, are expected to come in for wide attention in postwar modernization. ↑

Many welded tube mill installations have been made, and many more are under consideration. →

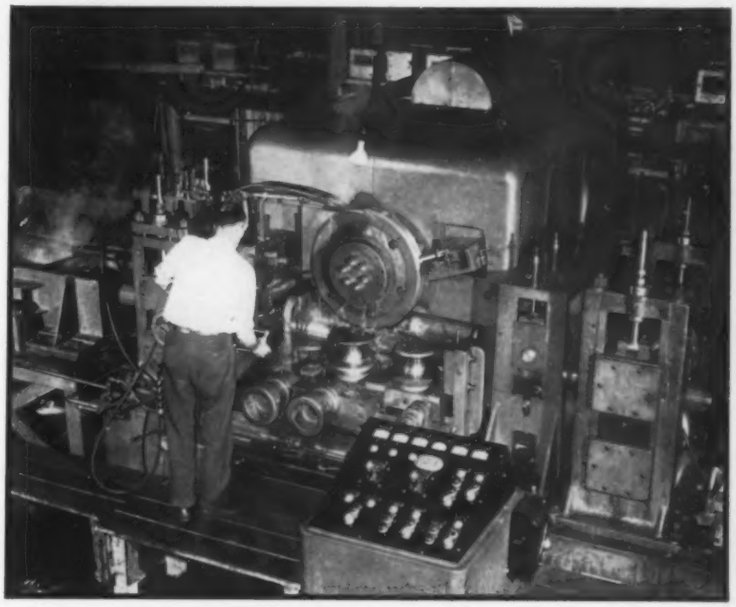
gun is being developed for the repair of large furnaces requiring a greater delivery speed of the refractory mix.

Related to refractory developments is the new use of carbon or graphite as stool inserts to prevent stickers. Preliminary tests have been made, using four grades of these materials, and the problem of stickers was eliminated entirely. However, the cost problem has not yet been sharply defined. The carbon and graphite inserts are more costly than cast iron stools, but the expense of stickers has been eliminated. The carbon inserts have a somewhat shorter life than straight cast iron, while graphite inserts show longer life.

Ingot processing has been made easier, particularly in the larger sizes, by the development of a new heavy duty flame cutting unit developed specifically for cutting ingots from 16 to 50 inches in thickness. It is particularly suited for hot top cutting, ingot slitting and cutting work on large castings and forgings. Using oxyacetylene gas, the unit replaces the oxygen lance and is designed for attachment to existing flame cutting machines.

The suggestion has been advanced that an open hearth furnace could be built with an all-door frontwall instead of the more conventional construction. This is based on experience gathered over a three-year period with a slab reheating furnace of this type construction. The advantage of such a step would lie in the fact that the entire furnace side of the frontwall would be covered with refractory material, and no black surface would be exposed to the furnace heat. In addition to economies of longer life, the amount of cooling water would be cut to a minimum or possibly eliminated entirely, and heat loss through the cooling water would be proportionately reduced. In such furnace construction, the refractory door lintel is supported from the top and in fact becomes a part of the suspended furnace roof. There is no need for auxiliary door arches to fill in space and to protect skewback channels or door frames.

With the end of the war, pressure on production has eased to the point where steelmaking facilities which have been in almost constant use for five years can now be shut down for major repairs and overhauling. It is reported that nearly half the melting units in the industry will be reconditioned in order to effect operating economies, now that the accent will be more sharply on cost and quality rather than on tonnage. It is anticipated that a considerable volume of new metal-handling equipment will be purchased to effect savings in time and fuel costs as well as to improve steel quality. The ingot phase of steel production has been carefully studied by all producers, and ingot practice is certain to undergo an extensive evolution in the light of wartime experience in the production of high quality steel. Refractory practice, already undergoing a major change due to development of new and better quality refractories, will probably move much farther in the direction of longer lining life and lower cost repair work, while the all-basic open hearth will grow in popularity.



ROLLING MILLS

The only major job of reconversion facing the steel industry is in its facilities for rolling flat-rolled products. The wartime pressure on plates, structural and other heavy sections has already given way to unprecedented demand for sheet and strip mill products, and the situation of 1944 which saw many of the major strip-sheet mills converted to plate production has been completely reversed and in some instances, continuous and semicontinuous plate mills are being pressed into service to help alleviate the extreme pressure for delivery in the lighter flat rolled products.

Before the war, capacity of the nation's sheet mills seemed more than adequate to meet demand, but events of the past year indicate that not only will the sheet mills have full schedules for the immediate future, but also that the load as now envisioned is of such magnitude that it is entirely within the realm of probability to expect construction of additional sheet capacity.

One trend which was being watched with considerable interest in prewar markets was the move toward cold

New designs of cold mills and temper mills have brought out improved characteristics in the finished strip.

reduced strip and away from hot rolled, pickled and annealed. That this will be the major demand item in the future seems assured by the unprecedented demand for new cold mills of all types. There are now more of these mills on order or being installed than at any previous time in history, and the new units are not confined to conventional types, but include novel and unique units as well. The cluster mill is growing in popularity, and mills of this type are now under construction and slated for 1946 operation at several points. They will be used particularly on high alloy, thin gage material.

The activity in new rolling mill construction is by no means confined to cold mills, however. There is additional capacity on order for roughing and finishing stands in strip mills, for tube mills and for bar mills. There will be a substantial volume of new bar mill capacity installed within the next few years, replacing much of the antiquated, high cost equipment which in many cases practically gave its all for the war effort. The problem of meeting postwar demands for closer tolerances in bar mill products faces hot mills as well as the cold drawing industry, and this means a need for complete reoutfitting at many plants.

There is probably more in store in the way of new development in the revamping of existing equipment, however, than in new mills. In almost every case, wartime developments have shown the operating economies which can be gained by speeding up existing units and thereby increasing capacity instead of adding new capacity. The trend toward higher speeds is therefore expected to gain momentum immediately, and in fact orders have already been placed for repowering and renovating several existing merchant mills, some sheet and strip mills, and a number of rod mills. Some inquiries are also reported on tube mills. Automatic control, usually in the form of electronic devices, is being installed on several units, including blooming and breakdown mills. This electronic control program continues to grow as good reports of its operation come back to industry generally, and also as new applications for it come from the laboratories.

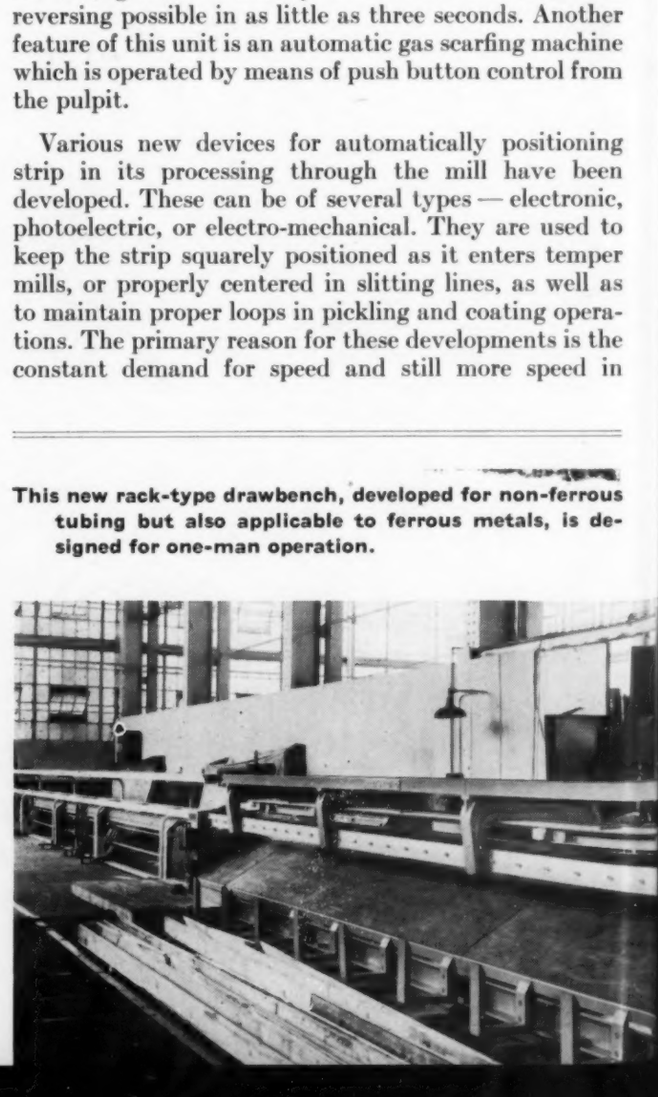
A great many mills have already been equipped with control systems using auxiliary rotating exciters of special characteristics. Such systems are growing in popularity not only because they eliminate the need for heavy-current contactors with their constant need for expensive maintenance but also because the new systems have made mill operation more flexible and have made it possible to increase speeds by closer control of timing on reversing operations.

More interest and considerably more research have been devoted during the past year to special shapes for use in welding operations. In some instances, special sections have been designed to be finished after rolling by means of flame cutting machines so that the sections can be used for engine frames, machine tool "backbones" and similar applications. This is a new development, and goes hand in hand with the development of special sections designed for use in constructing all-welded buildings, bridges and the like. This project has required virtually the full time of a number of roll designers during the past year and there is evidence that demand for these products will require considerably more research in the future.

Of interest in the production of semifinished steel is the new slabbing mill, which went into operation late last year in the Pittsburgh district. This mill, an 80-inch reversing universal type, is peculiar in that its rolls are driven by individual synchronized motors, and because of this, greater flexibility has been achieved, with reversing possible in as little as three seconds. Another feature of this unit is an automatic gas scarfing machine which is operated by means of push button control from the pulpit.

Various new devices for automatically positioning strip in its processing through the mill have been developed. These can be of several types — electronic, photoelectric, or electro-mechanical. They are used to keep the strip squarely positioned as it enters temper mills, or properly centered in slitting lines, as well as to maintain proper loops in pickling and coating operations. The primary reason for these developments is the constant demand for speed and still more speed in

This new rack-type drawbench, developed for non-ferrous tubing but also applicable to ferrous metals, is designed for one-man operation.



processing strip. With mill speeds up to 5,000 feet per minute now an actuality in at least one mill, and plans for even higher speeds taking shape on the drawing boards, the number of cobbles would reach tremendous proportions were it not for new controls which are more accurate and far more rapid than continuous manual checking of the operation.

An interesting piece of auxiliary equipment has been developed for use on plate mills. It combines a rotary edge shear and two integrally constructed scrap shears. This makes it possible to edge shear plate up to 1¼-inch thickness to the desired width and in the same operation cut the trimmed waste into scrap of charging box size. The unit will operate within a speed range of 9 to 60 feet per minute. The scrap shears are of up-and-down type and are synchronized with the main drive so as to operate at the same speed as the moving plate. They cut alternately so as to cut down on the total shearing power required.

Another application in the use of hard surfacing material has been its application to hot shearing blades. The welding of suitable hard surfacing metals was started originally to salvage worn blades. It has found many applications, however, in original equipment. Such blades may be made by applying the hard surfacing to a plain steel such as SAE 1045 resulting in a reduction in the total overall amount of alloy required in the blade.

FINISHING

More than ever before, the finishing aspect of steelmaking is exerting a pressure on total practice. The demand for better and better surface conditions has reached far below the rolling mill and is now concerning basic steelmaking operations — the ingot stage, melting practice and raw materials — far more than ever before. Many major research projects either were established or made progress reports during 1945 on various aspects of the problem of surface finish. Both cooperative and individual research on slag problems has received much attention because of the belief that through better understanding of the function of slag and its effect on the melting process, it will be possible to obtain better surface qualities in the finished steel. These and other basic steel researches are at one end of the line; at the other end are such direct finishing research jobs as the studies of thin coat electrolytic tin.

The tin plate picture has not yet been cleared up, largely because the supply of tin is still short and will probably remain so during the whole of 1946. However, several companies have anticipated the trend by announcing new programs for the expansion of their facilities for producing cold reduced black plate for tinning, as well as increasing their capacity for coating this additional black plate. Representatives of the major can producers have indicated that research programs are now well on their way toward eliminating the final bugs in the electrolytic tin plate picture. When these few remaining difficulties are eliminated, it is almost certain the demand for tin plate to be used in general line cans will be sufficient to warrant the construction of as much as 100 per cent more capacity for production

Announced during the year was a continuous pickler for strip in coil form. The design offers relatively high tonnage for low capital investment.

of continuously coated electrolytic strip in the lighter ranges of from 0.25 to 0.50 pounds of tin per base box.

There are other interesting developments in electrocoating of steel. Zinc coated strip and sheets have already taken their place as a commercially available product, and greater production on this item can be expected. Furthermore, there is a good possibility that new developments in continuous hot dipped galvanized flat rolled products can be expected. It was announced recently that at least two companies have authorized construction of new experimental developments aimed at establishing a continuous hot dip process of higher speed and greater flexibility than any previous equipment. It is assumed these new lines will be on flat rolled products only, although wire coating has also been under consideration.

A new type galvanizing machine for applying zinc to carbon steel wire by the Herman process found applications during the year. In this process, a stream of molten zinc is kept in circulation well above the dross-line. Wires coated by this method are drawn at speeds which in some fine sizes run up to 2,000 fpm, and is drawn to a diameter which corresponds to a 95 per cent reduction of area. Tests made on the final galvanized stock show no surface peeling and the finish is hard, dense and lustrous.

Coating, however, is only one phase of the whole problem of surface condition which is now occupying the spotlight. There has been increasing attention to the problem of providing a steel surface especially designed for application of a finish coat of enamel, paint, lacquer or porcelain. Newest and probably most interesting of these developments is the use of titanium, previously mentioned, as an addition agent to facilitate the use of porcelain enamel as a finish coat. Other addition agents are now under study and it is entirely possible that a whole range of special steels for use in applications requiring finishing coats may be the result. Some of the research already looks promising, but no definite announcements were made in 1945.

Initial advertising campaigns of the automobile companies on 1946 model cars accent the No. 1 problem of

car owners in the war years — body disintegration due to rusting. Many a fenderless car is still on the road, and the auto companies are stressing the fact that 1946 models are completely rustproofed. This means, of course, a greater importance of the various phosphate and other coatings. The bonderizing lines installed during the war and intended as a substitute for tin plate have been running at considerably less than capacity, but it now appears that demand for rustproofed material will be greater than had been anticipated. The automobile companies, of course, will probably elect to do their own work as they have done in the past, but there will probably prove to be many applications requiring coated steel where the fabricator will not want to invest in a line and will buy precoated steel.

Because these finishing operations represent a considerable cost item which is usually not covered adequately by extras, there has been some concern over means of cutting the cost, and during the year there have been several installations on pickling, coating and other finishing lines of higher power and higher speed motors and auxiliary equipment, as well as electronic controls in some instances. These are intended to reduce unit costs by speeding up the lines, and are tied in with an expected increase in demand for steels with partial or complete finishes applied in the mill. More demand has made possible expenditures for power and controls which would be uneconomic at lower levels of operation. War research has speeded up work on coatings. Numerous processes for bright coating of iron and steel with various nonferrous metals have been developed and introduced during the past year, or are now ready for introduction. Most of these are based on alkaline baths, as opposed to the usual acid type process. Two new bright copper processes have been announced which use this principle, one producing a coat sufficiently bright to be used as an undercoat for finish chromium without buffing, and the other producing a mirror finish with a slightly higher current density and using diethylene triamine as the key factor in the plating bath.

Allied with these processes but with a somewhat different application is the sodium hydride descaling process first announced late in 1945. Known also as the non-acid pickling process, it uses an alkaline base solution and the descaling is accomplished by reducing the scale, which is iron oxide, to metallic iron. The principal factors in the process are metallic sodium and hydrogen, which are supplied from dissociated ammonia. The sodium and hydrogen unite to form sodium hydride, an extremely unstable compound which attacks the iron oxide, forming metallic iron and sodium hydroxide. Currently, applications of this process have been limited to stainless steels, but its possibilities for other pickling applications are now under study.

Tube and cold finished bar producers have expressed considerable interest in a revolutionary type of drawbench which was placed in operation this year. It is a rack-type unit, and is designed for one-man operation. The first unit has been installed for drawing nonferrous tubing, but the unit can be applied to ferrous metals as well. The bench can be built in sizes ranging up to 50,000 pounds pulling capacity and with drawing speeds ranging from one to better than 300 feet per minute. Some of the advantages claimed for this unit include a constant, uniform pull; minimum amount of floor space required; and combined drive and pulling carriage which enables the operator to have complete control of the carriage at all times.

This 1,200 ft cooling conveyor, made with heat treated rivetless chain and ball bearing trolleys, simplifies a problem in a West Coast rod mill.

Costs of finishing seem to be the governing factor in most of the new developments in this sector of the steel picture. For example, there has been some interest in new grinding lubricants for use in finishing operations. This is due to the fact that new oils permit higher grinding speeds without danger of burning the steel, and higher grinding speeds contribute to lower unit costs.

FURNACES AND CONTROL

The shift from war to peace brought in a whole new set of problems on furnaces — or rather, brought back a lot of problems which had been dormant through the war period. With the accent on production of heavy goods during the war, heating problems became largely those of speed and of close control of heating processes.

The increase in soaking pit facilities during the war, required to maintain an even flow of ingots during the heaviest period of demand the industry has ever experienced, has increased immeasurably the knowledge of how these pits must be used to secure proper results. Some of the most modern installations, complete in almost every other respect, failed to operate properly until separate controls had been installed on each pit. Although identical in design, fuel and location, pits will vary widely in control requirements, and it has been shown conclusively during the war period that individual controls are necessary for uniform ingot conditions.

While it is true that the new developments of wartime are important and will certainly not be forgotten, many of them are not particularly applicable to the needs of civilian goods manufacturers. For example, the process of induction heating which was so widely used in shell and bomb production may have only limited application to flat rolled products under present conditions, and it is in this category that most civilian steel will fall. On the other hand, much of the work done on furnace atmospheres is of utmost importance and will be of considerable help to both steel makers and steel users in producing civilian goods.

This does not mean, of course, that induction heating has passed its peak application. The uses in electrolytic tin lines, for example, for reflowing the deposited coat are well known. It is also finding some applications in brazing work, such as brazing tungsten carbide tool tips to shanks. And its primary application in hardening steel parts is widening constantly.

Heat treating methods and procedures have been considerably sharpened by wartime necessity, and the studies of isothermal annealing and special quenching procedures, with their relationship to machinability, will in many cases determine the type of steel to be used. This factor has already begun to appear in steel specifications, and will probably answer the question as to the ultimate destiny of the low alloy NE steels and their associates.

Considerable improvement has been made through careful study and use of the isothermal transformation diagrams. This is not only true of the low alloy steels — it is also true of the older type alloys, known now as the AISI steels. However, the proper application of this material requires heat treating furnaces with a high degree of control that is able to follow complex procedure through the entire cycle with a minimum of variation. Orders for furnaces and controls requiring a high degree of accuracy are now at a higher level than ever before, and commercial heat treaters report an unprecedented backlog of business either booked or in the inquiry stage.

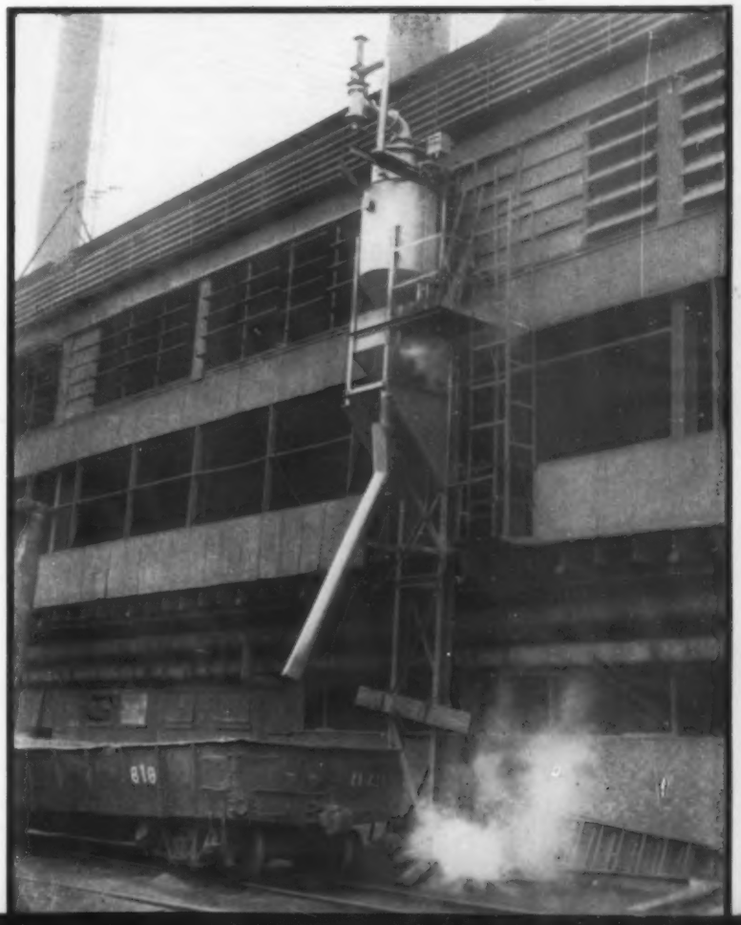
Isothermal annealing, austempering and martempering result in better machinability and greater dimensional stability, while the use of accelerated or high velocity quenching has contributed greatly to the use of the low-alloy steels. Special quenching fixtures which allow the quenching medium to be forced directly on the work are being used to considerable advantage.

The use of hardenability specifications, which is certain to govern buying of a very large fraction of steel henceforth, arises from these developments. Steel manufacturers have come to realize that these developments require furnace refinements, and as a result some of the new installations have involved more investment for scientifically designed burners, instrumentation and accessories alone than was formerly paid for the entire furnace installation.

Continuous heat treatment as an integral part of the production line continues to be a will-of-the-wisp which is the subject of much conjecture and some research, but only a few minor installations have been made. Sufficiently high speeds have been attained in one or two installations on bar stock and tubing to make the use of the principle seem possible, but the heating process has been applied only to small diameter stock and the available speed in the heating process does not match the speed of the line without the heat treatment. Since the urgent need of the present seems to be higher speeds, the use of the straightline integral heat treating process would seem to have hurdles yet to be crossed. It is entirely possible that, with low enough power costs, induction heating could do this job, but thus far the economics have not worked out. The existing installations are gas fired, with highly compact and efficient heating heads. This same principle, incidentally, has chalked up a successful record on tin brightening in continuous electrolytic tinning lines, where radiant tubes or radiant burner heads are used to do the reflowing job.

Like so many other developments noted in this review, furnace improvements are pointed at controlling the quality of the steel being produced, not in increasing quantity. To some extent, also, they are influential in lowering per ton costs. These two factors — higher quality and lower cost — are now the governing factors in the whole furnace and control picture, and in the whole steel picture as well. They have supplanted the drive for quantity which arose from the war needs, and although a period of tremendous civilian demand is ahead, the sights will be on these two items rather than how much can be produced and how quickly.

Vacuum units have been widely installed in connection with cleaning open hearth flues and checkers, and the principle is being developed for various other steel plant applications.



MATERIALS HANDLING

Because of wartime labor shortages, materials handling equipment was brought more sharply into focus as a means of augmenting the available labor supply and increasing worker efficiency. The lessons learned have been carried over into peacetime steelmaking, and it has been found that good handling works two ways, in that it not only increases output per man-hour but also is an important factor in good labor relations through improvement in working conditions.

An innovation in raw materials handling was installed in one steel plant this year in the form of double-ended ore transfer cars, powered by diesel electric units. The cars feature a complete set of operating controls at each end of the unit, connected by a covered tunnel which makes it possible for the operator to travel from one control position to the other without having to climb down and back up again on each reversal of direction. The cars will handle a 110-ton load up a 3 per cent grade, and are equipped with two power plants.

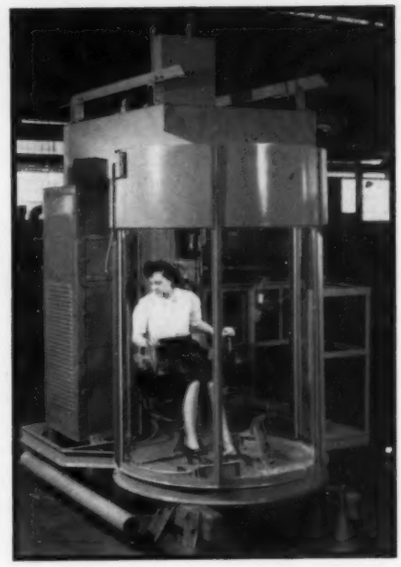
One new development which will be important along this line is the new full-vision, air-conditioned crane cab, which is completely enclosed in transparent plastic similar to the gunner's position in a bomber. The controls are both hand and foot operated, and are designed for use with any make of magnetically controlled crane.

The industrial truck, basic unit in almost all handling plans, has become even more versatile through specially designed attachments and auxiliary equipment which make possible the handling of bulk materials in large containers, acid carboys, and extra-length material such as rods, bars and tubes. Standard trucks, equipped with a power-driven wrench which is used to operate the opening ratchet on hopper cars, are very useful in large scale ore handling. These units are powered either from the truck's batteries or gasoline power supply, or by means of cables from the plant's power system operating through a motor generator set delivering 32 volts to the power wrench.

In order to extend the operating period of self-propelled transfer cars between battery changes, a special automatic charger has been installed on a car installed in an Ohio steel plant. The charging unit operates on an intermittent basis and enables the car to run long periods between battery changes. The charger operates whenever the car is out of motion and located adjacent to power lines.

An important new development in conveying equipment which has been successfully used to handle hot mill scale or scrap steel from shears is the oscillating trough conveyor. Instead of a continuous forward motion, this unit moves material by a constant forward and backward motion of a flexibly supported plate steel trough of rectangular cross-section. The trough is oscillated by an eccentric drive at a speed which will result in a forward travel movement of 20 to 50 fpm for most materials, depending on the flowability of the material handled.

Vacuum conveyors, actuated by steam jets, have had further application in open hearth plants as a means of cleaning checkers and flues. Similar units have been developed for applications in rolling mills and coke plants.



Developments in crane cabs have brought forth full-vision designs which are also air-conditioned in many cases.

Since only standard conventional trucks have been available through the war period, plant operators have been forced to improvise in order to adapt them to special applications. The coil up-ending truck, for example, which is standard equipment in almost all strip and sheet mills, can also be used to good advantage, with the addition of a scoop, to the handling of bulk materials in bins and from bins to cars, or vice versa. This same truck has also been used for charging low-temperature melting furnaces in nonferrous plants. Because of the widespread increase in wood-pallet handling, due primarily to the adoption of this method as standard on Navy contracts, a power-driven version of the familiar skid and pallet handling truck has become popular. This unit is propelled and the load lifted and lowered electrically, although it is guided from the floor as in the conventional hand-operated model.

Because of the unusual loads carried by overhead equipment as a result of heavy war production, some steel plants have instituted a mandatory inspection of cables, chains, slings and all other crane and hoist accessories, using not only visual inspection but proof-tests in the case of cables and chain. Defective chain is not repaired in the mill but is returned to the chain manufacturer for renewing and further tests. Grabs and tongs are also returned to the manufacturer, or are inspected by the maker's representatives and worn or defective parts replaced.

The various systems of dynamic control of crane hoisting were installed in many instances during the past year. Further experiments and research are being carried on by various manufacturers, all aimed at more speedy and efficient operation of the crane lift, and combining rapid and slow lifting and lowering under various conditions of load. One steel manufacturer reports a saving in time of nearly 50 per cent in some crane operations as a result of the installation of one of these control systems. The principal difficulty reported in a minority of cases is the maintenance job involved under heavy service conditions. More rugged control equipment and more effective dust seals seem to be the answer to this problem, according to electrical maintenance men.

MECHANICAL DEVELOPMENTS

Beyond question, the most difficult mechanical problem facing the steel plant engineer is that of lubrication. This is not a single problem, but a whole family of related difficulties. There is no really satisfactory answer to any one of the situations involved, inasmuch as the discovery of a satisfactory lubricant and lubrication system covering a difficult application merely opens the way to greater bearing pressures and closer tolerances, which open the lubrication problem once more. There have been enormous strides made in the development of satisfactory lubricants for high pressure, high speed and high temperature applications. The use of additives, either petroleum base or other organic material, seems to have gained further favor. Some experiments in the use of silicone greases have also been made, and the outlook is promising for these inorganic greases, although much research remains to be done before the best field of application for these products can be definitely outlined. Probably the most important single improvement has been the acceleration in the installation of centralized grease systems, which hit a new peak during the past year. Some steel plants now have several hundred systems installed, both hand operated and automatic, with consequent saving in actual time of the maintenance force, as well as minimized downtime due to faulty or improper lubrication. The shortage of trained lubrication men is as acute now as it has been at any time during the war, and there is no immediate relief in sight. Hence, the automatic system is an important factor in eliminating mechanical troubles arising from this cause.

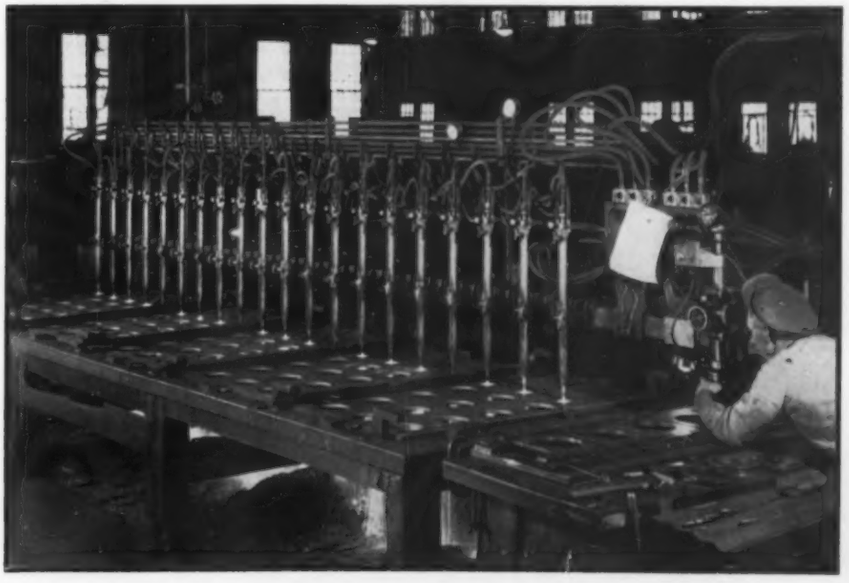
One source of difficulty in steel mill equipment in the past has been in applications where sliding friction is necessary, as in a sliding bushing or collar on a shaft. A new development promises elimination of such troubles, through the use of a "ball-bushing." This unit permits unlimited travel of reciprocating mechanical members that may be either round or square, or any variation of these shapes. The advantages gained from the use of ball bearings in rotating friction can thus be obtained on sliding members. The bushing contains a series of ball circuits. One side of the circuit carries the load, while the other side returns the balls in a clearance provided in the outer race member of the bushing. Rolling contact is thus provided, and sealed-in lubrication promotes long life of the unit.

Mechanical defects in steel castings can be located by means of X-ray inspection, or by radiography, but the process is expensive because of the high cost of radium or of high-powered X-ray equipment. It is of some interest, therefore, to note that as a by-product of the research on the atomic bomb, industry will have available in the future substantial quantities of radio active material at relatively low cost, which will reduce considerably the cost of this type of inspection. The process will be of considerable value in inspection of steel mill rolls for any initial defects, and for inspection after the rolls have been in service to detect any incipient trouble due to the wear and tear on the roll in the mill. The radiographic inspection process can also be used in the inspection of heavy plate, ingots and similar steel mill applications for the discovery of defects which might affect future rolling operations.

ELECTRICAL DEVELOPMENTS

It has been previously mentioned that the most important development of the past year was directly due to the end of the war. It was the change in thinking among steel producers from high production to low cost production. With the accent now switched from tons per hour to dollars per ton, it is only natural that higher operating speeds come in for an immediate study. As a matter of fact, the study has been going on for some time in flat rolled products, and 1945, bringing with it the end of the war, brought also the consummation of some of this thinking in terms of revamped electrical equipment on older mills and specifications for higher power on new equipment.

The twin-drive principle, using a separate motor to drive each roll in the mill, is finding increased favor. Already in successful operation in slabbing and plate mills, twin-motor drives are being applied to cold mills

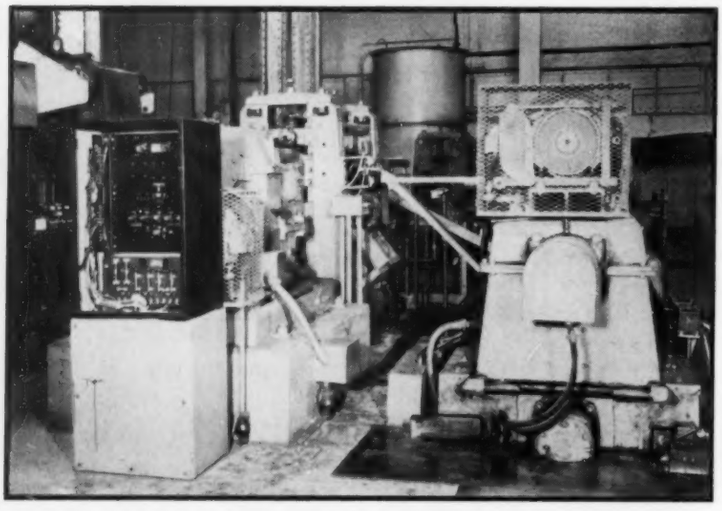


Flame cutting of many machine parts received great impetus in war production, and will no doubt carry over into peacetime production in many new applications.

and are under consideration for various finishing auxiliaries.

Work is already under way on a good example of this trend — a 42 in. 5-stand tandem mill for producing cold reduced black plate which has two unusual developments from the electrical standpoint. In the fourth and fifth stands of this unit, the drives will consist of two motors each, operating each roll individually, with auxiliary exciter control to maintain synchronized speed. This type of control will also be used to maintain proper tension. The second unusual development on this mill is that each stand will be powered from a separate generator. This is expected to give greater flexibility and make higher speeds possible. Auxiliary exciter control will also be used on generator voltage.

Similar electric controls will be used on voltage and on tension reels of eight new reversing mills now being built or in operation. Some of these units are experimental, while some are production units. There are several unconventional designs involved, including at least three modified cluster mills. Tension regulators and voltage control are being used on all these units. Of particular interest is a Canadian mill, being built for research work, which can operate as a 2-high reversing hot mill, a 2-high nonreversing strip mill with upcoiler, a reversing cold mill with tension reels on either side, or a nonreversing cold mill with an upcoiler. This unit is equipped with external regulating exciter type control of voltage and tension, and is driven by a 300/1,200 rpm 300 hp motor with two 40 hp 300–1,200 rpm reel motors and a 25 hp 400–1,200 rpm upcoiler motor.



Electronic controls, similar to the panel at the left of this photograph, are used for a wide variety of control problems — in this case, for control of tension rolls, idler roll, scanning head, winding reel and side register at the delivery end of an electrolytic tinning line.

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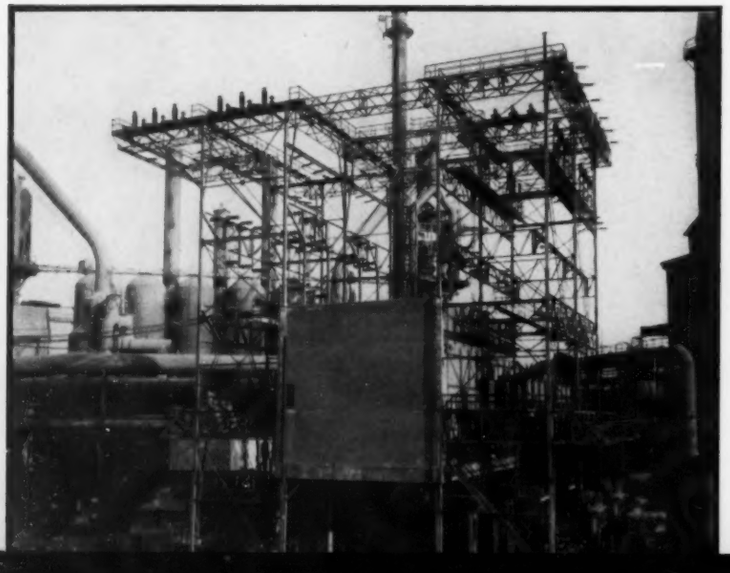
Two 10,000 kw electronic power converters are combined in this installation to form a frequency changer; 60 cycle switching and lines are to the left, 25 cycle switching and lines to the right.



In addition to the mills themselves, the electrical equipment of auxiliary units has come in for its share of attention. Three new pickling line power units are in the process of installation which will permit the speed of the lines to be tripled. The external exciter control system is being used here also on voltage control. At least one additional pickling line is being so equipped, and one cleaning line and an additional pickling line are being modernized and their speeds increased.

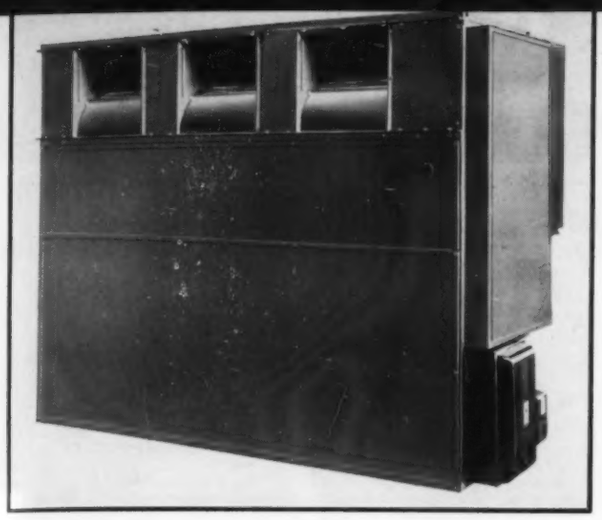
Mentioned under new finishing developments was a continuous galvanizing line, which has an interesting electrical development in its automatic flying shear. Using an electric-tie control, the shear is said to be the most accurate yet developed.

A 7,000 kw rectifier which parallels the motor generator sets on the hot strip mill of an Ohio valley plant has gone into successful operation. The special load balancing control which not only balances the load between the rectifiers and the motor generator sets but also between the two 3,500 kw rectifiers is operating satisfactorily. The rectifiers are equipped with anode breakers so arranged that should an arc-back occur, only one pole or anode will open, the balance of the rectifier remaining on the line. As soon as satisfactory vacuum is established, the pole which has been opened is automatically closed. During the aging of this equipment, some arc-backs occurred and the breakers functioned as planned. The arc-back was cleared without taking the rectifier off the line and without disturbing the mill operation.

Electronic control apparatus to maintain constant "tracking" of cold strip through slitting lines has been developed, enabling the slitting speeds to increase from 600 to 1,000 fpm. Electric-eye scanning tubes are installed on either side of the strip in such position that sidewise movement in either direction immediately breaks the beam circuit which actuates a motor drive connected to a sliding base on which the uncoiler is mounted. Any sidewise motion in the strip thus automatically creates a counteracting sidewise motion in the uncoiler itself.

To assist in lowering operating costs and boosting ingot production from electric arc furnaces, a "unified responsibility" substation has been developed. Featured elements of the new substation are higher voltage air blast interrupter or lower voltage disconnect switch, transformers with side mounted tap changers, operator's control cubicle and rotating external exciter type control.

A novel application of electronics is the new pressure gage which can be used in any spot where pressure measurement is required. Operating on the principle of

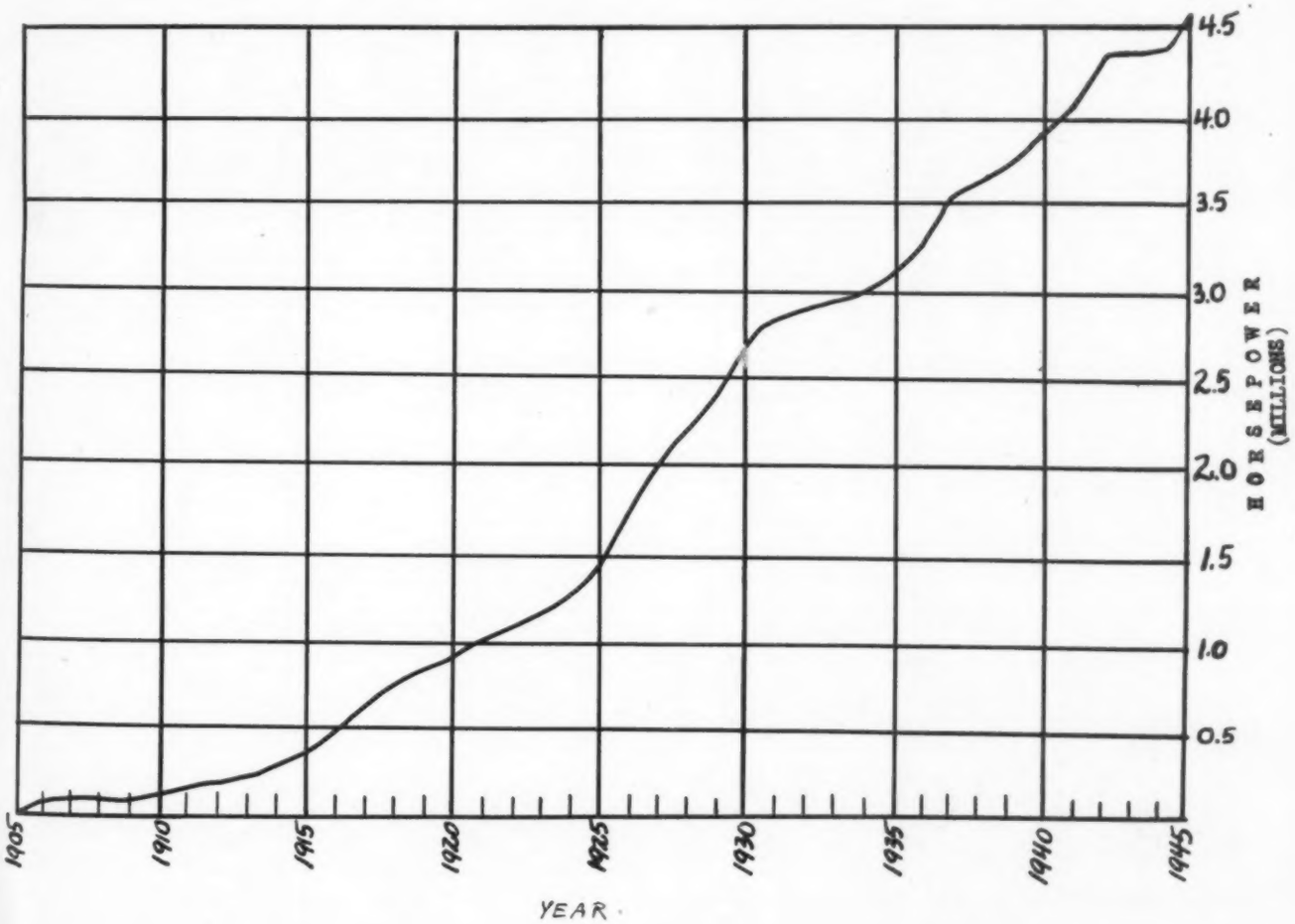


Additional motor capacity may be obtained in some cases by the use of a self-contained refrigerating unit, such as shown here, to cool water used in air coolers in ventilating systems.

the strain gage, the heart of the unit is a small cartridge which is inserted in the pressure vessel or pipe where pressure exists. The cartridge contains the strain gage, which is an elastic piece of metal whose electrical resistance varies in proportion to its length. The length also varies inversely with the pressure on the cartridge, and a sensitive electronic amplifier measures the variance in resistance of the gage and indicates or records the changes in terms of pounds pressure on a conventional type recording instrument.

Continuous heat treating processes continue to be in the forefront of the news, and it is therefore timely to report successful operation of a high speed wire treating process. Patenting, tempering and annealing of wire by the direct electric resistance method has been accomplished with satisfactory results. In this new process, the heating effect of an electric current, applied directly to the wire being heat treated, is utilized for extremely rapid and uniform heating through the cross section to the required temperature. Electrical resistance heating is over 90 per cent efficient; practically all the electrical energy is transformed into heat within the wire itself, which makes for lower heating costs as well as higher speed operation.

Designed for steel mills having highly concentrated and diversified loads, packaged substations furnishing both a-c and d-c power in one compact unit have been further developed within the past year. The combination of a 2,400 volt multicircuit substation, an a-c load center substation and a d-c load center substation is reported to save floor space, installation time and operator's time. The unit is a completely oil-less, metal-clad installation.



ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1945

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Kind of mill	Purchaser	Location	Manufacturer
1	300	850/1300	230	d-c	.....	Aluminum foil mill	Aluminum Company of Canada	Kingston, Ontario	General Electric
2	300	250/980	600	d-c	Geared	10 in. bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
3	300	250/980	600	d-c	Geared	10 in. bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
4	300	250/980	600	d-c	Geared	10 in. bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
5	300	514	2300	60†	Direct	Copper rod mill	Phelps Dodge Corporation	Fort Wayne, Indiana	General Electric
6	300①	200/300	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
7	300①	200/300	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
8	300	200/800	600	d-c	Direct	54 in. Temper mill reel	Weirton Steel Company	Weirton, West Virginia	Westinghouse
9	300	500/1000	250	d-c	Geared	54 in. Temper mill	Jones & Laughlin Steel Corporation	Cleveland, Ohio	Westinghouse
10	300	250/500	250	d-c	Geared	37 in. Sendzimir cold strip reel	Washington Steel Corporation	Washington Pennsylvania	Westinghouse
11	300	250/500	250	d-c	Geared	37 in. Sendzimir cold strip reel	Washington Steel Corporation	Washington, Pennsylvania	Westinghouse
12	300	375	2200	50	Direct	10 in. Intermediate rod mill	Aceros Nationale, S. A.	Mexico	Westinghouse
13	300	500/1000	600	d-c	Geared	Temper mill	Bethlehem Steel Company	Lackawanna, New York	Westinghouse
14	350	350/1200	600	d-c	Geared	29 in. Reversing cold mill reel	Wallingford Steel Company	Wallingford, Connecticut	General Electric
15	350	350/1200	600	d-c	Geared	29 in. Reversing cold mill reel	Wallingford Steel Company	Wallingford, Connecticut	General Electric
16	350	450	440	60*	Direct	Piercing mill	Bridgeport Brass Company	Bridgeport, Connecticut	General Electric
17	400	400	2300	60*	Direct	Copper rod mill	Phelps Dodge Corporation	Fort Wayne, Indiana	General Electric
18	400	350/700	600	d-c	Geared	Sendzimir mill	Thompson Wire Company	Boston, Massachusetts	General Electric
19	400	300/1050	600	d-c	Geared	4-Stand cold strip mill	Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	General Electric
20	400①②	575/750	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
21	400①②	575/750	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
22	400①②	575/750	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
23	400①②	575/750	600	d-c	Direct	2-Stand temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	General Electric
24	400	300/1050	333	d-c	Geared	54 in. Temper mill	Jones & Laughlin Steel Corporation	Cleveland, Ohio	Westinghouse
25	400	350/700	600	d-c	Direct	9 in. Bar mill	Copperweld Steel Company	Warren, Ohio	Westinghouse
26	400	400/800	600	d-c	Direct	9 in. Bar mill	Copperweld Steel Company	Warren, Ohio	Westinghouse
27	400	300/600	250	d-c	Geared	37 in. Sendzimir cold strip mill	Washington Steel Corporation	Washington, Pennsylvania	Westinghouse
28	400	600/750	350	d-c	Direct	56 in. Temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
29	400	600/750	350	d-c	Direct	56 in. Temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
30	400	600/750	350	d-c	Direct	56 in. Temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
31	400	600/750	350	d-c	Direct	56 in. Temper mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
32	400	360	4150	60*	Direct	Finishing mill	Triangle Conduit and Cable Company	New Brunswick, New Jersey	Electric Machinery Mfg. Co.
33	400	277	4150	60*	Direct	Intermediate mill	Triangle Conduit and Cable Company	New Brunswick, New Jersey	Electric Machinery Mfg. Co.
34	500	225/788	600	d-c	Geared	28 in. Reversing cold strip mill reel	McLouth Steel Company	Detroit, Michigan	General Electric
35	500	225/788	600	d-c	Geared	28 in. Reversing cold strip mill reel	McLouth Steel Company	Detroit, Michigan	General Electric
36	500	125/500	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
37	500	125/500	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
38	500	125/500	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
39	500	350/1050	250	d-c	Geared	Aluminum foil mill	Aluminum Company of America	Alcoa, Tennessee	General Electric
40	500	350/1050	250	d-c	Geared	Aluminum foil mill	Aluminum Company of America	Alcoa, Tennessee	General Electric
41	500	350/1050	250	d-c	Geared	Aluminum foil mill	Aluminum Company of America	Alcoa, Tennessee	General Electric
42	500	1200	2300	60†	Geared	Piercing mill	American Brass Company	Waterbury, Connecticut	General Electric
43	500	175/350	600	d-c	Geared	Rod mill	La Consolidada, S. A.	Mexico City, Mexico	General Electric
44	500	277	2300	60*	Direct	Rod mill	Phelps Dodge Corporation	Fort Wayne, Indiana	General Electric
45	500	250/550	600	d-c	Direct	Unitemper mill	Republic Steel Corporation	Niles, Ohio	General Electric
46	500	600/1500	600	d-c	Geared	36 in. Brass cold strip mill	Chase Brass and Copper Company	Waterbury, Connecticut	General Electric
47	500	300/450	600	d-c	Direct	54 in. Temper mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
48	500	350/700	600	d-c	Direct	54 in. Temper mill tension roll	Weirton Steel Company	Weirton, West Virginia	Westinghouse
49	500	200/400	600	d-c	Direct	12 in. Bar mill	Copperweld Steel Company	Warren, Ohio	Westinghouse
50	500	200/700	600	d-c	Geared	54 in. Tandem cold strip reel	Bethlehem Steel Company	Lackawanna, New York	Westinghouse
51	600	375/750	600	d-c	Direct	20 in. Reversing cold strip mill	McLouth Steel Corporation	Detroit, Michigan	General Electric
52	600	150/540	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
53	600	150/540	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
54	600	200/720	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
55	600	200/720	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
56	600	200/720	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
57	600	200/720	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
58	600	200/720	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
59	600	250/825	600	d-c	Direct	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
60	600	350/960	600	d-c	Geared	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
61	600	250/1200	750	d-c	Direct	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
62	600②	150/600	750	d-c	Direct	56 in. Tandem cold strip reel	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
63	600	150/600	750	d-c	Direct	56 in. Temper mill reel	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
64	600	150/600	750	d-c	Direct	56 in. Temper mill reel	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
65	600	200/700	750	d-c	Geared	56 in. Tandem mill reel	Granite City Steel Company	Granite City, Illinois	Allis-Chalmers
66	700	200/680	600	d-c	Direct	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
67	700	250/790	600	d-c	Direct	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
68	700	350/920	600	d-c	Direct	10 in. Bar mill	Bethlehem Steel Company	Lackawanna, New York	General Electric
69	700	300/900	600	d-c	Geared	Tandem brass strip mill	Chase Brass and Copper Company	Waterville, Connecticut	Westinghouse
70	700	300/900	600	d-c	Geared	Tandem brass strip mill	Chase Brass and Copper Company	Waterville, Connecticut	Westinghouse
71	700	450	4150	60*	Direct	Roughing mill	Triangle Conduit and Cable Company	New Brunswick, New Jersey	Electric Machinery Mfg. Co.
72	750	720	2300	60†	Direct	Copper rod mill	Phelps Dodge Corporation	Fort Wayne, Indiana	General Electric
73	750	200/400	600	d-c	Direct	Reversing brass mill	Western Cartridge Company	East Alton, Illinois	Westinghouse
74	750	500/1000	600	d-c	Geared	36 in. Sendzimir mill	Aluminum Company of America	Edgewater, New Jersey	Allis-Chalmers
75	800	250/750	600	d-c	Geared	30 in. Tandem brass cold strip mill	Stamford Rolling Mills Company	Springdale, Connecticut	General Electric
76	800	500	440	25†	Geared	16 in. Bar mill	Simmonds Saw and Steel Company	Lockport, New York	General Electric
77	800	150/525	750	d-c	Direct	3-Stand tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	General Electric
78	800	250/800	750	d-c	Direct	3-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
79	800	300/1100	750	d-c	Direct	42 in. Tandem cold strip reel	Weirton Steel Company	Weirton, West Virginia	Westinghouse
80	800	150/525	600	d-c	Geared	54 in. Tandem cold strip reel	Great Lakes Steel Corporation	Ecorse, Michigan	Westinghouse
81	800	600	2200	50	Geared	14 in. Merchant bar	Aceros Nationale, S. A.	Mexico	Westinghouse
82	1000	250/750	600	d-c	Geared	30 in. Tandem brass cold strip mill	Stamford Rolling Mills Company	Springdale, Connecticut	General Electric
83	1000	690/1015	250	d-c	Geared	29 in. Reversing cold mill	Wallingford Steel Company	Wallingford, Connecticut	General Electric
84	1000	400/800	600	d-c	Geared	4-Stand cold strip mill	Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	General Electric
85	1000	225/450	600	d-c	Geared	40 in. Sendzimir cold strip mill	American Rolling Mill Company	Butler, Pennsylvania	Westinghouse
86	1000②	250/860	600	d-c	Geared	40 in. Sendzimir cold strip reel	American Rolling Mill Company	Butler, Pennsylvania	Westinghouse
87	1000②	250/860	600	d-c	Geared	40 in. Sendzimir cold strip reel	American Rolling Mill Company	Butler, Pennsylvania	Westinghouse
88	1000	750	2200	50	Geared	10 in. Rod finishing mill	Aceros Nationale, S. A.	Mexico	Westinghouse
89	1250	150/450	600	d-c	Geared	28 in. Reversing cold strip mill	McLouth Steel Company	Detroit, Michigan	General Electric
90	1500	70/210	750	d-c	Direct	5-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
91	1500	300/750	600	d-c	Geared	4-Stand cold strip mill	Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	General Electric
92	1500	300/750	600	d-c	Geared	4-Stand cold strip mill	Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	General Electric
93	1500	70/210	750	d-c	Direct	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
94	1500①	150/300	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
95	1500①	150/300	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric

*Synchronous †Induction ①Twin Motor Drive ②Double Armature

Item	Horse-power	Revolutions per minute	Volts	Frequency	Method of drive	Kind of mill	Purchaser	Location	Manufacturer
96	1500①	175/350	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
97	1500①	175/350	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
98	1500①	200/450	750	d-c	Geared	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
99	1500①	200/450	750	d-c	Geared	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
100	1500①	200/500	750	d-c	Geared	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
101	1500①	200/500	750	d-c	Geared	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
102	1500	595	2200	50	Geared	24 in. Sheet bar and billet mill	Aceros Nationale, S. A.	Mexico	Westinghouse
103	1700	300/640	600	d-c	Geared	54 in. Tandem cold strip mill	Bethlehem Steel Company	Lackawanna, New York	Westinghouse
104	1700	300/640	600	d-c	Geared	54 in. Tandem cold strip mill	Bethlehem Steel Company	Lackawanna, New York	Westinghouse
105	1700	300/640	600	d-c	Geared	54 in. Tandem cold strip mill	Bethlehem Steel Company	Lackawanna, New York	Westinghouse
106	1750①②	250/438	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
107	1750①②	250/438	750	d-c	Geared	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
108	1750	70/210	750	d-c	Direct	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
109	1750①	225/450	750	d-c	Geared	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
110	1750①	225/450	750	d-c	Geared	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
111	2000	150/375	600	d-c	Direct	48 in. Hot strip mill	Republic Steel Corporation	Youngstown, Ohio	General Electric
112	2000	250/625	600	d-c	Geared	4-Stand cold strip mill	Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	General Electric
113	2000	70/175	750	d-c	Direct	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
114	2000	300/600	600	d-c	Geared	80 in. Tandem cold strip mill	American Rolling Mill Company	Middletown, Ohio	Westinghouse
115	2250①	250/450	750	d-c	Geared	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
116	2250①	250/450	750	d-c	Geared	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
117	2500	60/120	600	d-c	Direct	26 in. Blooming mill	A. M. Byers Company	Economy, Pennsylvania	General Electric
118	2500	225/450	600	d-c	Geared	48 in. Hot strip mill	Republic Steel Corporation	Youngstown, Ohio	General Electric
119	2500	225/450	600	d-c	Geared	48 in. Hot strip mill	Republic Steel Corporation	Youngstown, Ohio	General Electric
120	2500	130/260	750	d-c	Direct	56 in. Tandem cold strip mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
121	2500	150/300	750	d-c	Direct	56 in. Tandem mill	Granite City Steel Company	Granite City, Illinois	Allis-Chalmers
122	2500	225/450	750	d-c	Direct	56 in. Tandem mill	Granite City Steel Company	Granite City, Illinois	Allis-Chalmers
123	2500	300/570	750	d-c	Direct	56 in. Tandem mill	Granite City Steel Company	Granite City, Illinois	Allis-Chalmers
124	3000	110/275	750	d-c	Direct	5-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
125	3000②	150/312	750	d-c	Direct	5-Stand tandem cold strip mill	Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	General Electric
126	3500②	175/380	750	d-c	Direct	5-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
127	3500②	225/540	750	d-c	Direct	5-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
128	*3500②	200/400	600	d-c	Geared	60 in. Hot strip mill	Wheeling Steel Corporation	Steubenville, Ohio	General Electric
129	3500	125/312	750	d-c	Direct	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
130	3500②	225/450	750	d-c	Direct	42 in. Tandem cold strip mill	Weirton Steel Company	Weirton, West Virginia	Westinghouse
131	4000	80/200	750	d-c	Direct	3-Stand tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	General Electric
132	4000②	100/250	750	d-c	Direct	3-Stand tandem cold strip mill	Great Lake Steel Corporation	Ecorse, Michigan	General Electric
133	4000②	116/290	750	d-c	Direct	3-Stand tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	General Electric
134	4000②	400/745	750	d-c	Direct	5-Stand tandem cold strip mill	Columbia Steel Company	Pittsburg, California	General Electric
135	4000	250	6600	25†	Geared	76 in. Hot strip mill	Inland Steel Company	East Chicago, Indiana	General Electric
136	4000	150/300	640	d-c	Direct	54 in. Tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	Westinghouse
137	4000	175/350	640	d-c	Direct	54 in. Tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	Westinghouse
138	4000②	200/400	640	d-c	Direct	54 in. Tandem cold strip mill	Great Lakes Steel Corporation	Ecorse, Michigan	Westinghouse

*Synchronous †Induction ①Twin Motor Drive ②Double Armature

Company	Location	Type of mill	Number of motors	Total horsepower
Aceros Nationale, S. A.	Mexico	10 in. Intermediate rod mill	1	300
		10 in. Finishing rod mill	1	1000
		14 in. Merchant bar mill	1	800
		24 in. Sheet, bar and billet mill	1	1500
Allegheny Ludlum Steel Corporation	West Leechburg, Pennsylvania	4-Stand cold strip mill	5	6400
Aluminum Company of America	Alcoa, Tennessee	Aluminum foil mill	3	1500
	Edgewater, New Jersey	36 in. Sendzimir mill	1	750
Aluminum Company of Canada	Kingston, Ontario, Canada	Aluminum foil mill	1	300
American Brass Company	Waterbury, Connecticut	Piercing mill	1	500
American Rolling Mill Company	Butler, Pennsylvania	40 in. Sendzimir cold strip mill	3	3000
	Middletown, Ohio	80 in. Tandem cold strip mill	1	2000
Bethlehem Steel Company	Lackawanna, New York	10 in. Bar mill	18	9900
		54 in. Tandem cold strip mill	5	5900
	Sparrows Point, Maryland	2-Stand temper mill	6	2200
		56 in. Temper mill	3	1400
		56 in. Temper mill	3	1400
		56 in. Tandem cold strip mill	7	11,100
Bridgeport Brass Company	Bridgeport, Connecticut	Piercing mill	1	350
A. M. Byers Company	Economy, Pennsylvania	26 in. Blooming mill	1	2500
Chase Brass and Copper Company	Waterbury, Connecticut	36 in. Brass cold strip mill	1	500
	Waterville, Connecticut	Tandem brass strip mill	2	1400
Columbia Steel Company	Pittsburg, California	5-Stand tandem cold strip mill	5	15,500
		3-Stand tandem cold strip mill	1	800
La Consolidada, S. A.	Mexico City, Mexico	Rod mill	1	500
Copperweld Steel Company	Warren, Ohio	9 in. Bar mill	2	800
		12 in. Bar mill	1	500
Granite City Steel Company	Granite City, Illinois	56 in. Tandem mill	4	8100
Great Lakes Steel Corporation	Ecorse, Michigan	3-Stand tandem cold strip mill	4	12,800
		54 in. Tandem cold strip mill	4	12,800
Inland Steel Company	East Chicago, Indiana	76 in. Hot strip mill	1	4000
Jones & Laughlin Steel Corporation	Aliquippa, Pennsylvania	5-Stand tandem cold strip mill	9	14,600
	Cleveland, Ohio	54 in. Temper mill	2	700
McLouth Steel Company	Detroit, Michigan	28 in. Reversing cold strip mill	4	2850
Phelps Dodge Corporation	Fort Wayne, Indiana	Copper rod mill	4	1950
Republic Steel Corporation	Niles, Ohio	Unitemper mill	1	500
	Youngstown, Ohio	48 in. Hot strip mill	3	7000
Simmonds Saw and Steel Company	Lockport, New York	16 in. Bar mill	1	800
Stamford Rolling Mills Company	Springdale, Connecticut	30 in. Tandem brass cold strip mill	2	1800
Thompson Wire Company	Boston, Massachusetts	Sendzimir mill	1	400
Triangle Conduit and Cable Co.	New Brunswick, New Jersey	Finishing mill	1	400
		Intermediate mill	1	400
		Roughing mill	1	700
Wallingford Steel Company	Wallingford, Connecticut	29 in. Reversing cold mill	3	1700
Washington Steel Corporation	Washington, Pennsylvania	37 in. Sendzimir cold strip mill	3	1000
Weirton Steel Company	Weirton, West Virginia	54 in. Temper mill	3	1300
		42 in. Tandem cold strip mill	8	17,550
Western Cartridge Company	East Alton, Illinois	Reversing brass mill	1	750
Wheeling Steel Company	Steubenville, Ohio	60 in. Hot strip mill	1	3500

Types of motors purchased	Number motors	Total horsepower
Alternating current motors	15	12,700
Direct current motors	123	155,700
Total	138	168,400

Die Rolling

. . . . die rolling is one of the newer developments of the steel maker's art . . . . its development has transferred much of the tedious work of the forge shop to the rolling mill and resulted in increased production of complicated shapes with material savings . . .

by H. F. Marquardt

SUPERINTENDENT OF ROLLING

REPUBLIC STEEL CORPORATION

BUFFALO, NEW YORK

▲ HISTORY has not recorded the exact date that the art of iron making was discovered, but legend and relics prove that it was known prior to 5000 B. C. The working of iron is mentioned in the first book of the Bible but during the Middle Ages these methods seem to have been lost to civilization and were rediscovered in the sixteenth or seventeenth centuries.

The products of early forgers, blacksmiths, armorers and iron masters were confined to articles such as swords, armour, helmets, nails, cook pots and horse shoes. They were laboriously hammered and assembled by hand so that their cost made them available only to the wealthy or those who took them by force. During the Middle Ages it was said that an English knight often carried more wealth on his person and his horse than the value of many a Scotch farm.

The invention of gun powder in the thirteenth century caused changes in warfare and weapons, which created new demands for iron and steel. However, the production or maintenance of iron or steel articles remained a laborious process.

The growing demands and needs made men think. Water driven power hammers came into use and in 1783 Henry Court invented the rolling mill. In 1798 Eli Whitney, of cotton gin fame, secured an order from the new United States government to manufacture 10,000 rifles for the army on a three year contract. It was a formidable task by the old methods. However, Whitney's Yankee ingenuity soon improved upon old methods. While the first two years of his contract saw only 500 rifles completed, it found his plant outfitted with a strange assortment of power boring, cutting and milling machines of his own devising.

Thus were born the first machine tools for turning out standardized, interchangeable parts in quantities. This revolutionary method of manufacture enabled him to complete his outsize contract in the few remaining months and ushered in an era that was to lift the load of drudgery from millions of human backs and change the economic structure of the United States and the world. In like manner the turret lathe, then the profile lathe, came into being. In 1856 Henry Bessemer invented the Bessemer process and William Siemen's open hearth furnace appeared in 1861.

The needs of our forces during the Civil War and the expansion of our country by railroads and prairie wagons immediately thereafter, caused a constantly increasing demand for iron and steel products, many of them of identical design. In 1861 the Colt Arms Company began making duplicate, interchangeable forgings for the manufacture of firearms, using board drop hammers for this purpose.

After the war new forge plants made their appearance and forgings began to find use in the machinery building

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field. Some rolling mills started to make railroad tie-rods, flat in the center with rounded ends so they could be bolted to hold rails at proper intervals. Wagon hardware of round, oval, and flat shapes were needed. Articles of this sort were usually made by having a varying groove in one roll and a flat roll against this groove so that timing was not needed.

Inventors remained active, and from 1865 to 1920 more than 87 patents were issued covering the rolling of various articles such as wagon axles, freight car axles, bicycle spokes, horseshoe nails, buggy steps, chain and similar parts. Most of these patents were inoperative and since few of the articles ever appeared on the market it can be assumed that most methods were impractical.

During World War I and immediately thereafter the rapidly expanding automobile industry with its production lines created urgent demands for many thousands of identical steel parts in numbers which exceeded the capacity of their forge shops.

In 1920 Witherow Steel Company, owner of a rolling mill in the Pittsburgh district, conceived the idea of die rolling parts to meet this demand and started experimental work. The first die rolled article was stream line wire for planes, followed by a semi-finished rear axle blank having a flash. This axle was rolled from a leader bar to section in one pass. After shearing, the flash was removed and machining was required only on the spline and wheel ends since the intermediate or long taper was rolled to length and gauge tolerances close enough to be used as rolled. The second blank was a reforging blank for an automobile front axle. This was rolled with the same close tolerances but required forming at the ends and spring pad sections. Other articles resulting from these investigations were wheel spokes, gear shift levers, tie rods, rail wedges, spring clips and numerous other blanks used by the automobile manufacturers and railroads.

In 1925 William H. Donner decided to die roll on his 14 in. mill in Buffalo. Machinery and equipment were installed and in April, 1926, die rolling began.

Some years later, an infringement suit was instituted, wherein the Witherow patents were upheld, but in 1929 both companies were absorbed by the newly formed Republic Steel Corporation. Since the Donner equipment was more modern and rugged it was decided to discontinue work at Pittsburgh and do all die rolling in Buffalo.

Up to this time all die rolling, other than some experimental work, had been of the flash nature. In 1930 Republic Steel, under the Thomas H. Sloan patents, began the manufacture of flashless die roll blanks. These blanks, while not as close to a finished article as the flash blanks, leave sufficient metal for the forger to make the largest part of a projected article and at the same time greatly reduce the metal where the forger requires less. This type of product found such acceptance in the forging field that despite depressed conditions in the steel industry, the tonnage of die rolled products increased several hundred per cent. However, the trade was reluctant to have only one source of supply and it became advisable to license other steel makers for die rolling. These now include Carnegie-Illinois Steel Corporation, Bethlehem Steel Company and Jones and Laughlin Steel Corporation.

At Republic, when the sales department feels that a customer has a problem which can or should employ die rolling, the die roll engineer is contacted. He is furnished with a description of the part to be made as well as a knowledge of the machinery and methods to be used in making the part.

Given this, he lays out the design for a blank of proper length, weight and shape. Stock is distributed so that there is sufficient to make the large sections of the forging but is reduced for the smaller dimensions. Proper allowances must be made for extrusion or contrusion, the degree of transition from dimension to dimension, and for the amount of reduction to the leader bar which may vary from little to over 75 per cent.

The design is given to the die roll shop. Here two sleeve rolls are placed on one mandrel and the periphery

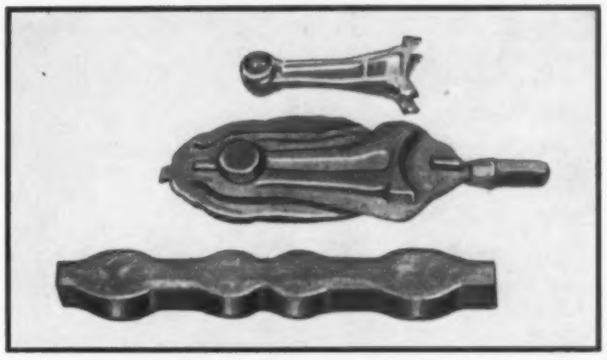


Figure 1 — Three steps in the manufacture of a connecting rod: at bottom, blank as rolled; center, forging with flash; top, finished connecting rod.

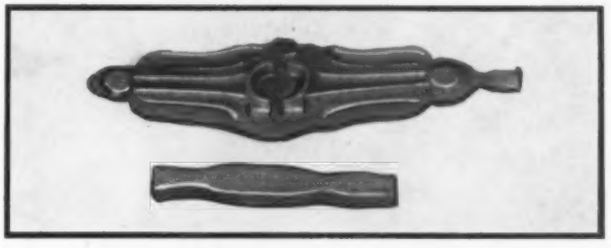


Figure 2 — Top shows connecting rod forging with flash, and bottom shows connecting rod blank as rolled.

of the rolls is scribed to mark the points where variations in the grooves are to be located. In scribing the two rolls at one time, the same keyway is used and later little adjustment is needed to get rolls in time or registration in the mill. The rolls now go to the lathes where a lead groove is cut for each pass. This is a groove corresponding to the smallest dimension desired, and is cut by lathe because it is quick and economical. The larger parts of the groove are cut on vertical or horizontal milling machines, or perhaps on a fly cutting machine, and require considerable time, skill and patience. Templates are furnished by the layout man so that proper transitions from section to section are maintained. In the final operation the rolls go to a grinding stand where the grooves are ground and polished to micrometer dimensions.

By allowing for a gate between blanks it is possible to redress most rolls several times. This is done by reducing the diameter of the rolls enough to remove worn parts of the grooves.

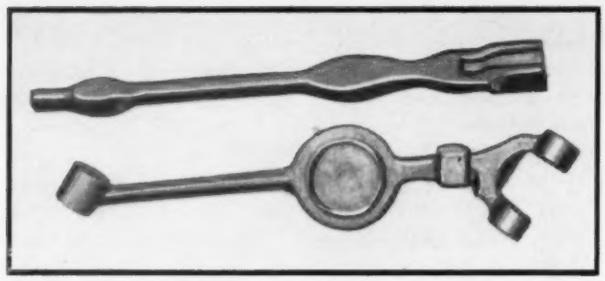
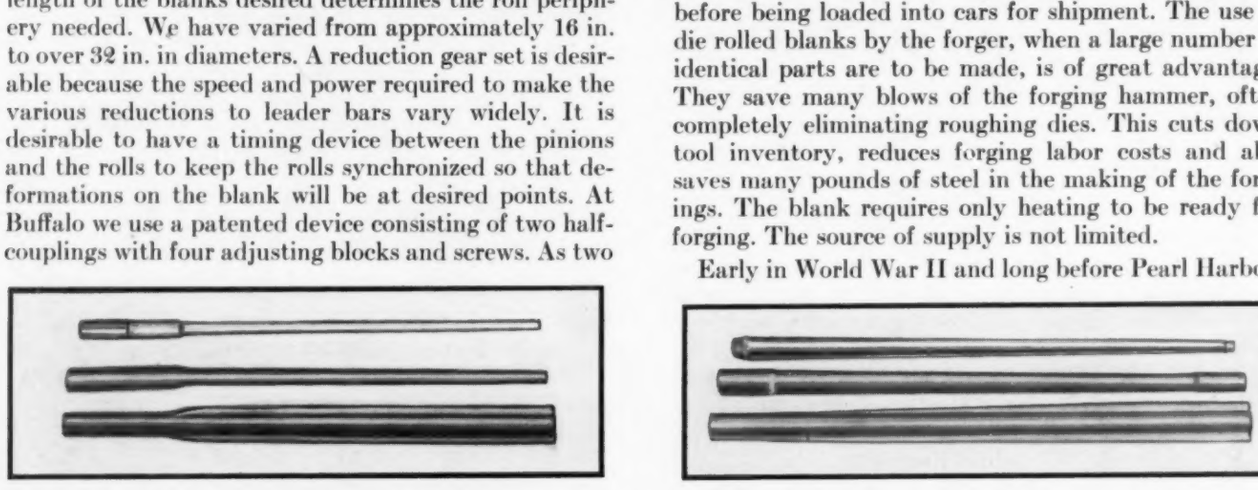


Figure 3 — Top shows trimmed rolled blank for support arm; bottom shows trimmed forging.

In the mill, rolls are required to convert a bloom or billet to a predetermined leader bar just as one uses an oval to form a round or a diamond to form a square. The finishing or die roll stand should be very sturdy and large enough to take a wide range of roll diameters, since the length of the blanks desired determines the roll periphery needed. We have varied from approximately 16 in. to over 32 in. in diameters. A reduction gear set is desirable because the speed and power required to make the various reductions to leader bars vary widely. It is desirable to have a timing device between the pinions and the rolls to keep the rolls synchronized so that deformations on the blank will be at desired points. At Buffalo we use a patented device consisting of two half-couplings with four adjusting blocks and screws. As two blocks are released and the opposite blocks screwed in the other direction the top roll can be moved to micrometric dimensions for any desired adjustment.



Figures 4 and 5 — Gun barrel blanks as rolled at bottom; trimmed rolled gun barrels are shown in center, while at top are shown finished machined pieces.

The rolls can be solid or of the composite type which employs a set of sturdy mandrels upon which cylindrical sleeves or rolls are mounted. These sleeves are, in effect, circular dies with grooves cut in opposite directions, one roll running clockwise and the other counter-clockwise. When assembled in the housing with proper bearings, guides and other equipment, a uniform leader bar is entered between these rolls and they deliver a long bar of closely identical die rolled forging blanks. Each blank may have widely varying cross sectional areas and dimensions.

The temperature of the leader bar, speed of the die rolls and surface condition of the rolls may vary the length, surface, or area of the die rolled blank. The amount of reduction, the size of the piece being reduced, and the direction of reduction all enter into the making of the desired blank. These reductions, as was mentioned, may run over 75 per cent, as in the rolling of an automotive support arm blank, the equivalent of a $3\frac{1}{8}$ in. round is reduced to the equivalent of a $1\frac{7}{16}$ in. round and in the rolling of a front axle blank a leader dimension of 2 in. is reduced to $\frac{3}{16}$ in. in the one passage through the die rolls. A thorough knowledge of these variables, as well as a full understanding of the customen's final application are essential to successful die rolling.

After cooling, these blanks are further processed; some steel grades require annealing to give better shearing qualities. The long bars are sheared into separate blanks. This may be done by running the bar against a stop or it may involve the measuring of some important length of each blank before it is sheared. Each piece is usually given an inspection as it leaves the shears and may need grinding to remove a slight rolling or steel imperfection.

If of the flash type, the blanks next go to the trimmer where each piece is laid in a press and the flash is removed. From the trimmer the blanks go to the grinding stands where the trimmed portion is smoothed up and the blank is again inspected. Blanks not straight enough go to a gag straightener for processing.

The blanks are then neatly stacked and banded into bundles. Here they are subjected to a final inspection before being loaded into cars for shipment. The use of die rolled blanks by the forger, when a large number of identical parts are to be made, is of great advantage. They save many blows of the forging hammer, often completely eliminating roughing dies. This cuts down tool inventory, reduces forging labor costs and also saves many pounds of steel in the making of the forgings. The blank requires only heating to be ready for forging. The source of supply is not limited.

Early in World War II and long before Pearl Harbor, when our arsenals were in the throes of the heroic job of trying to equip armies with the new Garand rifle, as well as arm our increasing number of planes with machine guns, the armory people eagerly sought any help or short cut that would speed up production. Col. E. L. Ford (now brigadier general), then in charge of production at the U. S. Armory in Springfield, Massachusetts, and some of his staff came to the Republic plant at Buffalo to investigate the possibilities of using die rolled blanks for gun barrels. He was skeptical of the mill's ability to furnish them in the quantities desired. However, specifications, quality of steel and grain flow lines had been satisfactorily met in previous demonstrations to the Army.

After witnessing the Buffalo mill roll 6500 Garand rifle barrels per hour and watching the subsequent processing accomplished at a satisfactory rate, Col. Ford was convinced that the Buffalo plant could make all the rifle blanks needed in the country. Production went on apace and during an exchange of visits it was discovered that a small sleeve closely machined and shrunk on the muzzle end of a machine gun barrel could be rolled into the die roll blank and become an integral part of the barrel, thus saving considerable time and money. Col. Ford stated that the use of die rolled blanks had increased his production 40 per cent. Altogether, Republic furnished several millions of rifle blanks before other

methods could get well into production and to date approximately 7,000,000 various die rolled rifle barrel blanks have been made. These range from the 24 in. Garand weighing less than 5 lb to the .50 cal aircraft machine gun over 60 in. long and weighing over 51 lb.

Die rolling is not a fad or passing novelty. It has been in commercial use for many years. During ten years of operation, Witherow Steel Company produced over 150,000 tons of various die rolled blanks. The applications are many and varied. Blanks measuring from 1½ in. to 75 in. and weighing 1¾ lb to 330 lb have been produced. The parts made from die rolled blanks are equally varied. These include automobile crankshafts, front and rear axles, connecting rods, steering arms, steering knuckles, support arms, camshafts, aircraft connecting rods, tank and truck forgings, truck lifting arms, gun barrel blanks, drill bits, pipe wrench jaws, plow beams and many others.

The greater capabilities of Republic's Buffalo mill, coupled with the wider use of the flashless blank and augmented by the production made by licensees greatly increased production figures, so that by the end of 1944 over 1,325,000 tons or approximately 200,000,000 die rolled blanks had been used by the trade. This production figure would have been considerably higher if it had not been found necessary to suspend the building of automobiles due to war emergencies.

DISCUSSION

PRESENTED BY

H. A. CARTER, Superintendent, Roll Department, Bethlehem Steel Company, Lackawanna, New York.

C. P. HAMMOND, Superintendent, Roll Mills and Billet Department, Atlas Steels, Limited, Welland, Canada.

H. F. MARQUARDT, Superintendent of Rolling, Republic Steel Corporation, Buffalo, New York.

R. G. GRAHAM, Combustion Engineer, Republic Steel Corporation, Youngstown, Ohio.

J. F. BLACK, Assistant Works Manager, Atlas Steels Limited, Welland, Canada.

S. A. SMITH, Superintendent of Rolling Mills, The Steel Company of Canada, Limited, Hamilton, Canada.

H. A. Carter: We have rolled several sections, such as crankshaft blanks, control arms, steering arms, camshafts and hinge sections. Crankshaft blanks are made on our 28 in. mill, the smaller blanks on our 12 in. mill.

The difference between Republic's die rolling and our preformed blanks is that we do all our machining in the roll shop on a regular roll lathe and 90 per cent is done in the roll lathe which cuts down the costly hand work.

We originally used flexible couplings but have since used gears to insure proper alignment in the mill.

The 28 in. mill diameters did not suit the length of the crankshafts so we used an old pair of 26 in. housings, machining the base to suit 28 in. shoes, and then by using 24 in. mill roll mandrels and sleeves we obtained the correct roll diameter. Thus, we rolled 100 tons an hour, using 24 in. rolls in a 26 in. housing fit to a 28 in. mill.

C. P. Hammond: First, I note that the flashless blanks are not finished close to size and have to be forged. Are there any sizes that do not require forging?

H. F. Marquardt: No. The flashless blank is made for the forger. We make the blank to fit his dies. It is never intended to be a finished article.

C. P. Hammond: On flash die rolling is there any particular way to take care of the flash? Is it permissible to let the flash go freely or should it be contained to a certain degree? Outside of the groove, should the flash go out straight or should it be more or less contained, so that the flash forms in bulb fashion?

H. F. Marquardt: If there is a considerable reduction in a large article, then it is very much better to have a degree of taper to your flash; otherwise it tends to buckle and vary the length of the article.

C. P. Hammond: Approximately how much life can be obtained in a die roll, if you have a gate between each blank which you reduce during dressing?

H. F. Marquardt: The length of the blank is maintained or nearly so, and the gate is reduced. When the gate is reduced to an inch or so, it becomes too short for shearing properties.

C. P. Hammond: Do you more or less have to alter the size of the gate or the length of the gate to save material?

H. F. Marquardt: Yes.

C. P. Hammond: Is the material excess or scrap material?

H. F. Marquardt: Yes

C. P. Hammond: Approximately what percentage of die roll blanks are forged after rolling?

H. F. Marquardt: In pre-war times, in the case of crankshafts, the percentage of flashless blanks would be 75 per cent and 25 per cent would be flash blanks.

C. P. Hammond: What percentage of the flash blanks have to be reforged?

H. F. Marquardt: Only parts of them have to be reforged. For instance, front axle ends are reforged, and the center is not. The rear axle is machined only, with no reforging. In other words, the flash blank is very close to the finished article.

C. P. Hammond: The question of the delivery guide set up should be an interesting one.

H. F. Marquardt: When we first started to die roll, the guide setup, looked as though we would never get anything through the guide, and that the first bar would run around the roll and smash everything. However, the flash does the primary job of delivering the bar. The guide can only touch the roll at the smallest dimension of the piece and cannot touch it at the biggest dimension. You can often put your finger between the roll and guide, but the bar does not go down through this opening.

R. G. Graham: How hot is the steel in die rolling?

H. F. Marquardt: Just about the same as in rolling practice on rounds. The hottest parts are 2,100 F. Most blanks are rolled at 1,900 degrees. That is not true with the flash jobs which are ordinarily smaller and probably rolled at over 2,000 degrees with some running between 1,900 and 2,000 degrees.

R. G. Graham: Is there more than one pass in the roll on the small rifle barrels?

H. F. Marquardt: The small Garand has eight, the .50 calibre has five passes, although it depends on the face of the roll as to how many passes you can get in the roll.

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R. G. Graham: If you start out with one billet, do you deliver a number of blanks in a string and then shear them off?

H. D. Marquardt: That is right. In a Garand I think there are about 40 or 42 in a string.

R. G. Graham: Is this all done in the rolling?

H. F. Marquardt: Yes.

J. F. Black: What size billet do you use?

H. F. Marquardt: On the 14 in. mill, 4 in. by 4 in. are used and for die rolling 7 in. by 6½ in. is the largest size. On the Garand rifle, we average 25 tons per pass. On the .50 caliber the average probably runs about 60 tons. On crankshafts, the die roll shop touches the rolls up with a grinder when they come over to the shop. I do know we roll as high as 3,000 tons on a pass.

C. P. Hammond: What yield do you get from the billet section?

H. F. Marquardt: On the flashless work which is a special requirement, we take only 75 per cent from the ingots through the bloom, and our die roll yields are 93 to 95 per cent. The yield depends on the amount of flash to be trimmed off which on some blanks will ordinarily run about 15 per cent.

C. P. Hammond: Are you the first people that ever rolled this crankshaft in this manner?

H. F. Marquardt: As far as I know we were.

S. A. Smith: In regard to the leader going into the pass, will that lengthen the distance in between, referring to the slide bar?

H. F. Marquardt: I think you have a tongue and groove pass there, and if you put in too much stock it will overfill.

S. A. Smith: Can you lengthen a blank other than through the length of the groove cut in the roll?

H. F. Marquardt: Yes, if you increase the size of the bottom roll.

S. A. Smith: To bring the rolls back, do you need only to turn one roll?

H. F. Marquardt: You would have a whole lot of bottom rolls, as the surface of both rolls wears.

S. A. Smith: Could you make two tongues or passes?

H. F. Marquardt: We did that years ago at Lackawanna. You can alter the length of the plates. If you have a variable speed, you can very your length quite a bit — ¼ to ⅜ in. The lengths of tie plates could be varied as required by the use of a smaller or larger bottom roll where you have something to work on as on a 30 inch blank. You cannot do much with a short tie plate.

Member: Do you get more wear on the bottom roll?

H. F. Marquardt: Yes.

Member: When you have an exceptionally heavy job, isn't there a flow of metal forward?

H. F. Marquardt: That is right. In fact, we had some groups that produced a bar two inches longer than the measured distance of the groove in the roll. We also have some that are just slightly shorter. It depends on which way the reduction is made on the bar or rolling "off" or "on," as we call it.

Member: When you are rolling some items, is the work all done in one direction, or is the bar turned at any time?

H. F. Marquardt: You have only the one pass, and therefore the bar is not turned.

THE Blast Furnace Skip Hoist - III

. . . . in concluding this series on skip hoists, this article considers the entire charging operation and how its requirements affect skip hoist design . . . .

by Gordon Fox

VICE PRESIDENT

FREYN ENGINEERING COMPANY

CHICAGO, ILLINOIS

▲ THIS is the third and concluding paper of a series on this topic. In the first paper presented ("The Blast Furnace Skip Hoist" by Gordon Fox, A. I. S. E. Yearbook, 1943), the dual drive skip hoist with two complete, symmetrical drives made its debut. A new principle of control was also projected, employing series-parallel connection of adjustable speed compound wound motors for operation from a constant voltage supply. In the second paper ("The Blast Furnace Skip Hoist" by Gordon Fox, Iron and Steel Engineer, March 1945), the use of similar motors with adjustable voltage control for the lower portion of the speed range, was described. The advantages of these drive and control arrangements were pointed out, with particular emphasis on the adequacy of torque development in relation to torque requirement and the most effective use of the motive capacity installed.

The current paper is directed primarily to the elementary consideration of the blast furnace charging operation with a view to indicating just how the skip hoist fits into the charging picture and how the requirements affect skip hoist design and selection. As most modern blast furnaces are provided with a scale car, double skips and a conventional McKee distributor, the study relates to furnaces so equipped. For the most part, the figures refer to furnaces of the 1000-1500 ton category. As related to smaller furnaces, the principles are similar.

Presented before the Birmingham and Detroit sessions of the annual meeting, September 17 and 24, 1945.

It is not within the scope of this paper to discuss the distribution of blast furnace burden and the consequent influence on furnace performance. It may be remarked, however, that furnaces are normally burdened with alternate layers of ferrous material and coke. The depth of the coke layer employed varies considerably at different plants, the consensus apparently being that a coke layer approximating 15 in. in depth, at the stock line, is most advantageous.

On this basis the charging of a furnace might conform with the following:

Stockline diameter equals 20 ft — Area equals 314 sq ft.

At 15 in. depth, 392 cu ft coke are required for one layer.

At 31 lb per cu ft this equals 12,200 cu ft coke per charge.

This would be sent up in two consecutive skips, each containing 196 cu ft of coke, weighing 6,100 lb.

The iron produced from this coke at a coke rate of 1700 lb per net ton equals 7.2 tons.

At 100 per cent ore charge, 51 per cent Fe in the ore, 93 per cent Fe in the metal and 4 per cent loss of ore in flue dust, the ore required per charge equals:

$$\frac{7.2 \times 0.93 \times 2000}{0.51 \times 0.96} = 27{,}000 \text{ lb}$$

At 150 lb per cu ft, this ore occupies 180 cu ft.

A rational charge for such a furnace would be based on two skips of coke and one skip of ore, with necessary stone interposed. A likely arrangement would be

OCC/OSCC/. This would produce 14.4 tons of iron per full round of 7 skips.

Such a charging program would require skips in excess of 200 cu ft volume.

TABLE I

CHARGING SUMMARY

For furnace with 20 ft stockline diameter, 15 in. coke layer

Iron produced net tons per day	Rounds per day	Skips per day	Ave. seconds available per skip
1,000	70	490	177
1,200	83	580	149
1,400	97	680	127
1,600	111	777	111

Alternatively, it may be desirable to consider the limitations imposed by the fact that most American blast furnace plants having large furnaces are equipped with scale cars rated at 25 gross tons capacity, having two hoppers, each capable under normal conditions of handling about 225 cu ft (250 cu ft hoppers, 90 per cent full) or about 34,000 lb of ore.

Based on 100 per cent ore charge, 51 per cent Fe in the ore, 93 per cent Fe in the metal and 4 per cent loss of ore in flue dust, the iron produced from 34,000 lb ore equals:

$$\frac{34{,}000 \times 0.96 \times 0.51}{0.93 \times 2{,}000} = 8.9 \text{ net tons}$$

At a coke rate of 1,700 lb per ton of iron, the coke required per charge is 15,200 lb, having a volume of about 490 cu ft. This would normally be sent up in two skips of 245 cu ft of coke each. These coke loads would fill a 250 cu ft skip tub 98 per cent full.

Distributed over a 21 ft 6 in. diameter stock line (362 sq ft), 15,200 lb of coke results in a coke layer of 1.35 ft. (16 in.) depth.

TABLE II

CHARGING SUMMARY

For furnace using 250 cu ft skips and 25 ton scale car

Iron produced, net tons per day	Rounds per day	Skips per day	Ave. seconds available per skip
1,000	56.2	394	220
1,200	67.5	473	183
1,400	78.7	552	157
1,600	90	630	138

The ability of the charging equipment to keep a blast furnace filled is dependent, in a very large measure, upon the filling cycle selected. This fact may be noted most readily by reference to Figure 1 which shows the number of skip trips necessary per day to fill furnaces producing various quantities of iron when employing several filling cycles more or less typical of prevailing practice. The chart is based on the assumption that, when charging coke, the skips will be filled to their maximum capacity (95 per cent of skip volume is occupied), the ore being adjusted to correspond. The chart is based on a coke rate of 1,700 lb per net ton of iron and on a coke weight of 31 lb per cu ft. The figures derived from the chart can be proportionately adjusted for other conditions. Curves A, B, C and D represent filling cycles in use at different plants in which coke skips represent 40, 45, 50 and 57 per cent of the total skips. Curve E shows a theoretical optimum in which all skips sent up would be substantially full of material and in which 62 per cent of the total number of skips would be devoted to hoisting coke. It should be noted that cycle D requires only about 2/3 as many skip trips as cycle A, for equal iron tonnage. In general, the higher the ratio of coke skips to total skips, the smaller the number of skip trips required to produce a given tonnage.

It may also be noted that a cycle such as D advantageously utilizes the time required for coke charging by devoting it to loading the scale car. For instance, a two-compartment scale car might load two compartments with ore and stone while the first two coke skips are loaded and hoisted, and the scale car might load one compartment with ore while the second two coke skips are being loaded and hoisted.

Consideration of the foregoing may lead to the following general conclusions:

(a) The use of a 250 cu ft skip tub in conjunction with a scale car having 250 cu ft compartments is logical because the skip can handle all that the scale car can deliver from one compartment, and also because the coke corresponding to a maximum normal ore delivery from one scale car compartment comfortably fills two skips and gives a rational coke layer on a typical large furnace stockline diameter.

(b) If a skip tub of 200 cu ft capacity or more is used in connection with a moderately favorable filling cycle, such as C or D, 1500 net tons of iron can be produced daily with a requirement of 900 skip trips or less per day. A 250 cu ft skip tub will require 700 skip trips, or less, per day for 1,500 tons of iron.

(c) A 250 cu ft skip tub, when filled, can hold about 37,500 lb of ore, and the hoisting equipment should be capable of handling such a skip. Due to scale car limitations, however, ore charges in excess of 34,000 lb are not to be expected as a basis of normal operations.

If, to supply a blast furnace, 1,000 skip trips are required in 24 hours, the average time available for each skip is 1,440 min $\times$ 60 sec $\div$ 1,000, or about 87 seconds. If 500 skip trips per day suffice to keep the furnace filled, the average time available for each skip trip is about 174 seconds. This time must include loading intervals. Typically, 10 seconds may be considered as the time necessary for discharging the material from the skip at the furnace top and for simultaneously loading material into the skip in the stock house. During this period, while material is being delivered to the small bell hopper, the rotation of the distributor is necessarily deferred. Thus, if a cycle of skip movement requires 45 seconds, the total trip time, including the loading and discharging interval, will approximate 55 seconds. This is only about 2/3 of the 87 seconds mentioned above as available if the requirement were 1,000 skip trips per day. Some such time margin is necessary in order that the rate of charging may be accelerated or forced beyond average requirements in order to bring up a low burden level. The fact that average or normal charging require-

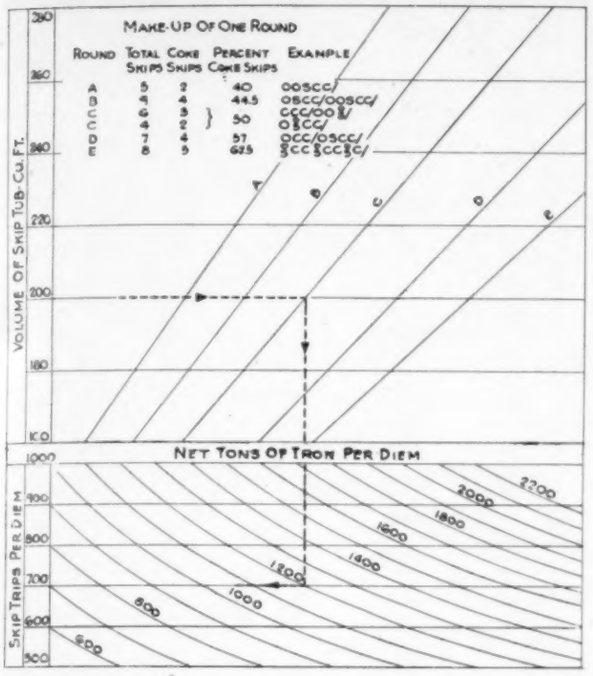


Figure 1 — Chart giving number of skip trips per day for various rates of production and filling cycles.

ments can be met by a given equipment and filling schedule is not enough. The rate of forced charging which may be attained is the real criterion of the adequacy of the furnace filling arrangements.

The time required for a skip movement or cycle depends upon the length of the trip, the full running speed and the reduced speeds near the start and finish of the trip. Figure 2 shows a typical cycle of movement for a hoist having a nominal rope speed of 350 ft per minute as applied to a rope travel of 200 ft. It is indicated that the cycle requires about 45 seconds. Inclusive of the charging and discharging interval, the minimum time per skip trip will be practically 55 seconds.

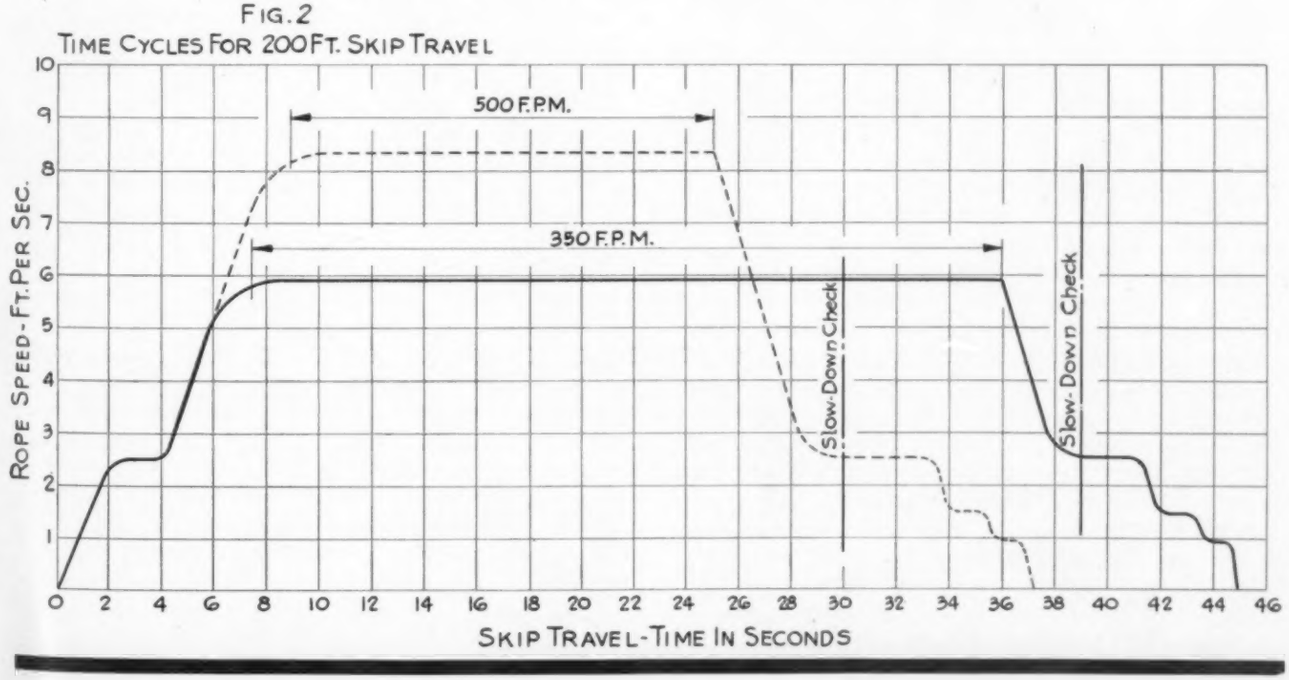
Figure 2 also shows, by dotted lines, the effect of increasing the running rope speed to 500 ft per minute. The time for a cycle becomes 37.2 seconds and a minimum interval between skips would be about 47.2 seconds.

Comparison of these curves and figures shows that an increase of about 50 per cent in hoisting speed results in a possible decrease of only about 13 per cent in the interval between skips. This statement must be immediately qualified, however, by an if — a very large *if*. As explained in the following paragraphs, this indicated 13 per cent decrease in time of skip intervals may not be realized at all. This is due to the fact that the skip hoist is an intermediate mechanism in the furnace charging operation. On the one hand, its movements must be related to those of the scale car; on the other hand, they must be related to the movements of the furnace top mechanisms, namely, the distributor and the bells.

Let us first consider the relationships between the skip hoist movements and the movements of the furnace top mechanisms.

Figure 3 is a comparison of the results which can be obtained at four different rope speeds ranging from 600 fpm to 350 fpm Figure 3 (a) shows the results obtained if a rope speed of 600 fpm is employed for the hoist. A skip cycle requires about 34 seconds. At a point about 26 seconds after the start of the skip cycle and just before the skip is capsized, a check is made to insure that the skip has slowed down and that the small bell has completed its operation and is closed. If either action has not taken place, the skip is stopped. The figure shows the arrangement wherein the skip hoist is not permitted to start its cycle until after the distributor has com-

Figure 2 — Typical time cycles for 200 ft skip travel at 350 and 500 fpm rope speeds.



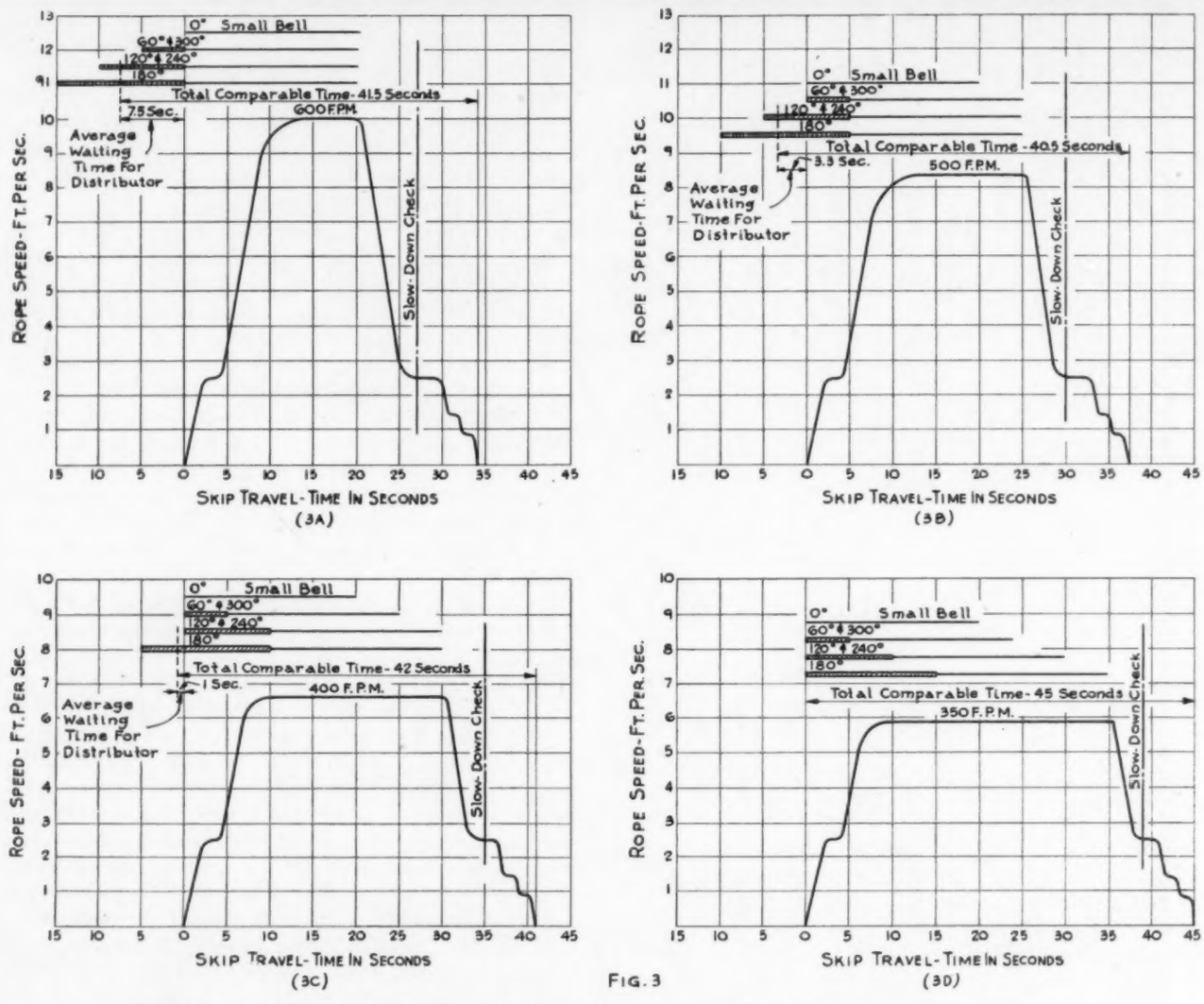


Figure 3 — Typical time cycles for skip hoists with rope speeds of 350, 400, 500 and 600 fpm.

pleted its rotation. With this arrangement the skip and small bell start their movements simultaneously. Since the small bell cycle normally requires not more than 20 seconds, the small bell will always close before the slow-down check point of the skip cycle is reached, except where a delay is interposed by the large bell. However, with this arrangement, a charging delay is introduced, averaging 7.5 seconds, while waiting for distributor rotation. In consequence, the minimum average interval between skips, under forced charging, comprises the skip-trip of 34 seconds plus 7.5 seconds average time waiting for distributor rotation, plus 10 seconds charging and discharging time, or a total of 51.5 seconds.

Figure 3 (b) shows the results obtained if a rope speed of 500 fpm is employed for the hoist. The skip cycle now requires about 37.2 seconds. The slow-down check point is at about 30 seconds. Because of this fact, it is not necessary to hold the skip hoist at all times until after the distributor has completed its rotation. It is necessary to delay starting the skip until the distributor has traversed 60 degrees for the 120 degree and 240 degree angles. It is necessary to delay starting the skip until the distribution has traversed 120 degrees for the 180 degree angle. On this basis, the small bell should be closed 25 seconds after the skip has started and 5 seconds before the slow-down check point is reached. With this arrangement the average delay while waiting for distributor rotation is reduced to 3.3 seconds. The minimum average interval between skips, under forced charging, equals 37.2 plus 3.3 plus 10, or 50.5 seconds. This compares with 51.5 seconds previously indicated as resulting when a rope speed of 600 fpm is used. The paradoxical result is indicated that a reduction in skip speed actually expedites the charging.

Figure 3 (c) shows the results obtained if a rope speed of 400 fpm is employed for the hoist. The skip cycle requires about 41 seconds. The slow-down check point is at about 35 seconds. With this amount of skip time available, it is necessary to delay starting the skip only when the distributor rotation is 180 degrees and then only to the extent that the distributor completes its first 60 degree increment of rotation before the skip is started. With this arrangement, the average delay while waiting for distributor rotation is slightly less than one second. The minimum average interval between skips, under conditions of forced charging, equals 41 plus 1 plus 10, or 52 seconds. This interval is substantially the same as that resulting with 600 fpm rope speed.

Figure 3 (d) shows the results obtained if a rope speed of 350 fpm is used. The skip cycle requires about 45 seconds. The slow-down check point is at about 39 seconds. With this amount of skip time available, it is not necessary to delay starting the skip under any conditions because the distributor can rotate 180 degrees and the small bell can open and close within a total of 35 seconds. With this arrangement, the interval between skips, under conditions of forced charging, is 45 plus 10, or 55 seconds. This is only slightly longer than required with the previously considered alternatives.

In view of the fact that many skip hoists have been installed having relatively high rope speeds, it has often been necessary and has become an accepted practice to arrange the charging control to require that the distributor operation be completed before the skip hoist is started. This insures that the skip will not be faster than the furnace top. It is the easy way to cancel out excessive hoist speeds. But it does not seem rational to install a fast skip hoist and then to impose a heavy handicap against its starting for the very reason that the hoist is too fast.

In instances where the skip hoist, the distributor control and the charging control for a given blast furnace have been supplied as a unit, their operation has been better coordinated as shown in Figure 3 (b) or (c), with entirely satisfactory results.

The general conclusions to be derived from the more or less typical survey presented, may be summarized in the following statements:

(a) Proper coordination between skip hoist and furnace top mechanisms is of greater significance than skip hoist speed in the attainment of maximum charging potentialities.

(b) The most advantageous speed for the skip hoist of a typical blast furnace, in terms of charging capacity, is one affording a skip cycle of about 40-45 seconds. Little, if anything, is gained through reduction of the cycle time below 40 seconds.
A hoist having a nominal running speed of 300 fpm can complete a skip cycle involving a trip of 175 ft in about 45 seconds. To complete a 225 ft trip in the same time, a nominal running speed of about 400 fpm is required.

(c) The distributor control should be designed in conformity with the tabulation given in Table III.

In foregoing paragraphs the relations between the skip hoist and the furnace top mechanisms have been considered. It is necessary, additionally, to consider the limitations imposed by the scale car. Figure 4 is offered to indicate the nature of these relations. This figure gives a comparison of the results obtainable in connection with a seven-skip charging round comprising OCC/OSCC/. For easy reference, the skips may be numbered 1-2-3-4-5-6-7. The upper diagram A shows the results in connection with a 45 second skip cycle. the lower diagram shows the results in connection with a 35 second skip cycle. In diagram A, the skip is not delayed waiting for the distributor. In diagram B, the skip is not started until after the distributor completes its movement. In both cases, the time allowed for discharging is 10 seconds. The time allowed for charging coke is 15 seconds and for ore, 10 seconds.

TABLE III
SCHEDULE FOR DELAYING SKIPS

Time of skip cycle at maximum speed	Distributor angle	Advisable to delay skip until distributor has traversed
Over 45 seconds	...	None
40 — 45 seconds	180	60 deg
35 — 40 seconds	180	120 deg
	120	60 deg
	240	60 deg
Less than 35 seconds	For all distributor angles, hold skip until distributor has completed rotation.	

It is assumed for purposes of the diagram that the scale car requires 180 seconds to load ore and stone into two compartments, and 120 seconds to load ore only into one compartment. These figures serve to illustrate the principles involved. They are believed to be reasonably representative. Both diagrams assume automatic or preset charging of the coke skips.

The diagrams show that the scale car is the bottle neck during the first half of the round and that a 35 second skip cycle, requiring about 70 per cent increase in the rope speed of the skip, effects no saving in time for the total round. This is the same, namely 420 seconds, in diagrams A and B. The diagrams refer to 180 degree rotation of the distributor. Taking other angles into consideration (not shown) the time saving over an average round, accruing to the faster skip cycle, is about 5 per cent.

It may be argued that the scale car will require less time than shown in this diagram, or that more time will be required for charging the skips. If this contention be granted, the scale car bottle neck disregarded, and the ore and coke charging times increased to 15 seconds and 20 seconds respectively, it is still indicated that a 70 per cent increase in skip hoist speed results in less than ten per cent increase in charging capacity, all distributor angles considered. On the other hand, if a filling cycle less favorable to scale car operations is employed, it is quite possible that a fast skip will add little or nothing to the charging potentialities. The exact results vary in individual cases, but the general conclusion seems to be warranted that the use of a high rope speed for the skip hoist results in only a nominal and perhaps a negligible gain in charging capacity.

Some operators prefer that the small bell should at all times be opened immediately after the distributor has completed its rotation. It may be stated that this variation in charging method does not affect the foregoing conclusion.

The argument is sometimes advanced that no time is lost through holding the skip until the distributor has completed its rotation because there is commonly an interval between skips anyway, during which the distributor can complete its operation. This statement is more or less true with respect to ordinary conditions when there is marginal time to burn, but it may well be repeated that forced charging conditions are the criterion. The argument then loses its point. It can hardly be contended that fast skips are necessary to meet normal conditions when they would merely serve to increase the duration of the already existing idle intervals.

Figure 4 shows that one round of 7 skips requires about 420 seconds. On this basis, about 1,440 skip trips

per day are indicated as a maximum possible rate with forced charging. If the skip size and loading are such that 800 skips per day are normally required, the marginal potentiality is about 80 per cent.

A total of about 330 ft depth of material is deposited upon a 21 ft 6 in. stockline in 24 hours while producing 1400 tons of iron. The average rate of deposition of material is 0.23 fpm. With reference to this tonnage and this average charging rate, an 80 per cent margin affords the possibility to bring up a low stockline at a rate of about 0.18 fpm or 1 ft in 5.5 minutes or about 11 ft per hour.

Figure 5 is of interest in that it depicts the influence of the running rope speed on the power demand and the motive equipment of a skip hoist. Curve (a) shows that if the blast furnace could be charged continuously by a conveyor, less than 50 hp would probably be required to drive such conveyor. Curve (b) shows that if a low rope speed is used, the work of hoisting a skip load is distributed over a minute or more. In consequence of this fact, the power demand is moderate and the size of motive equipment is also modest. This curve approximately indicates the conditions which apply when a single motor is used to drive a dual-drive hoist at reduced speed. Curve (c) shows the nature of the power demand if a rope speed such as 400 fpm is used. Curve (d) shows the power demand and the magnitude of the motive equipment required in conjunction with a hoist speed such as 600 fpm. The work of hoisting is concentrated into about 30 seconds. Additionally, the kinetic energy stored in the moving parts and subsequently returned by them approaches four times what it would be for a 300 fpm rope speed. The effect of high rope speed in creating a high and peaked power demand is evident. It will be realized that other stresses are affected similarly.

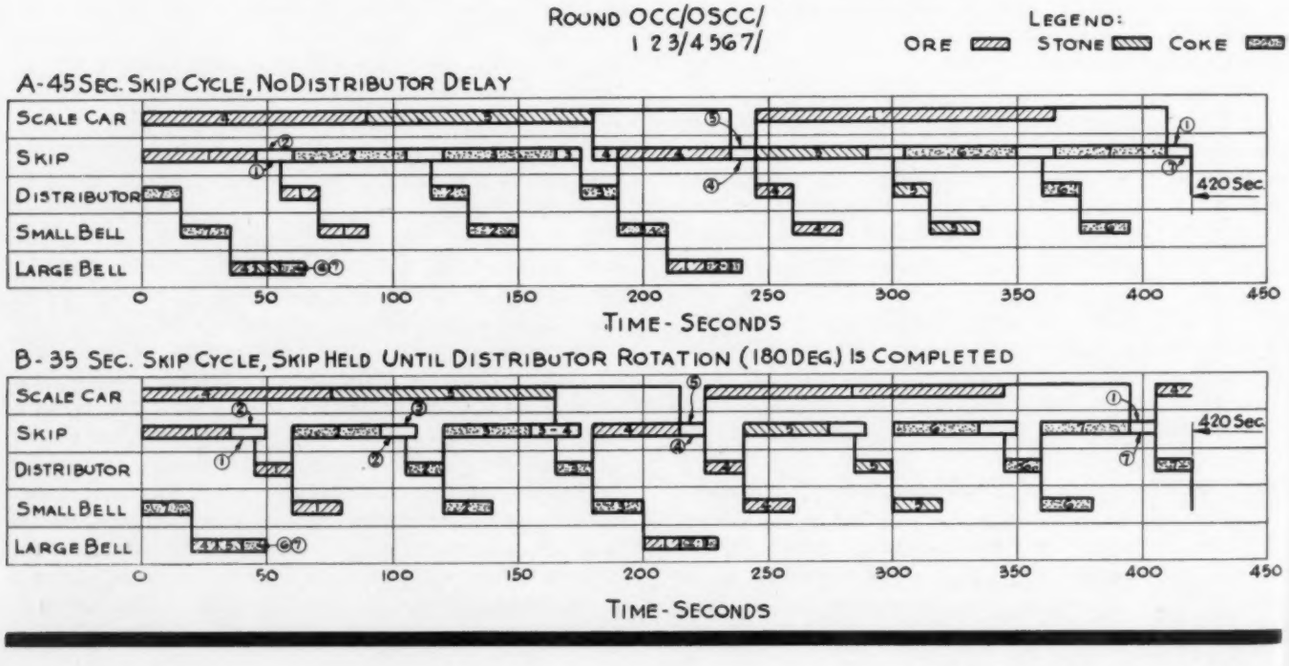
One conclusion is almost obvious, viz: in order to permit the use of moderate size drive equipment, to minimize and level off the demand on power supply and lines, and to reduce wear and tear, the speed of a skip hoist should not be higher than that necessary to enable it adequately to perform its function, including marginal capacity for forced charging. Conversely, improved coordination of furnace charging mechanisms confers a substantial benefit in permitting the satisfactory use of lower hoisting speeds.

The foregoing discussion has brought out the fact that, under normal conditions, blast furnace charging facilities are more than capable of maintaining the furnace stockline; they have marginal capacity which results in idle intervals. It has also been pointed out that decreased hoisting speeds result in lowered power demand and easier service on equipment. In recognition of these facts, it is good practice to operate a skip hoist normally at a somewhat moderated speed; for instance a hoist having a maximum nominal rope speed of 350 fpm may advantageously be operated at about 300 fpm except during occasions when forced charging becomes necessary. The use of adjustable speed motors facilitates this practice by the simple device of selective predetermination of the extent of field weakening at running speed.

The final topic for consideration in this paper relates to the merits and demerits of constant voltage and adjustable voltage supply for blast furnace skip hoists. This topic will be considered under the headings of performance, reliability, efficiency and cost.

Performance — Before the advent of the control scheme in which series-parallel connection of two motors is employed in combination with field-forcing and field-weakening of the motors, all types of magnetic contactor control, operating from a constant voltage supply, left much to be desired in the matter of performance. Torque capacities were limited, load division between motors was a problem, dumping speeds tended to be erratic and acceleration and deceleration were not too smooth. These and other deficiencies now associated, in the minds of many, with magnetic contactor controls have

Figure 4 — Comparison of charging schedules on 45 and 35 second cycles.



been eliminated by the improved control scheme described in the first installment of this paper. It may now be categorically stated that, within the limits of rope speeds to and including 400 fpm, magnetic contactor control now available for use with constant voltage supply is fully equal in performance with controls employing adjustable voltage. Where rope speeds of 450 fpm and more are involved, the range between running speed and dumping speed becomes rather great for most satisfactory operation from a constant voltage supply. For such rope speeds, the use of adjustable voltage is warranted from the standpoint of performance.

Reliability — Hoists equipped with dual drive and operated from the constant voltage "shop circuit" are inherently highly reliable. If the d-c power is lost, the furnace cannot be charged in any event. If either motor or any part of either drive gives trouble, the hoist can be operated from the other motor. Control faults are seldom of a type requiring extended delay for their correction. The ability to run with either motor, isolating portions of the control for possible repairs or adjustment, further minimizes the likelihood of serious time loss due to controller troubles. The simplicity, the low current values and the nominal rheostatic losses associated with the improved scheme of contactor control further enhance its reliability. Magnetic contactor controllers of this type have operated a year without changing contacts. This would seem to be very near to the irreducible minimum in maintenance and to represent substantial perfection as to reliability.

The controls associated with adjustable voltage systems can be simple and as reliable as the best constant voltage controls. However, the injection of additional links in the chain of power supply does introduce hazards. Faults in rotating apparatus are apt to be more difficult to locate, and lead to extended repair periods. A hoist drive which is dependent upon half-a-dozen rotating armatures is inherently less reliable than a drive which is operable with two armatures, or a single armature if necessary.

The deficiencies of the adjustable voltage system in the matter of reliability can be offset through the use of reserve apparatus, at considerable expense and complication, or by schemes such as outlined in the second installment of this paper.

Efficiency — The older types of magnetic contactor controls, operative from constant voltage supply, involved heavy rheostatic losses as indicated in Figure 11 of the first installment of this paper. The losses were often comparable to the power usefully employed. The concept therefore has wide acceptance that all magnetic contactor controls for blast furnace skip hoists are inefficient. In the improved contactor control described in the first installment of this paper, rheostatic losses have been reduced nearly to the vanishing point. They represent a relatively insignificant part of the total power consumption. Operation from a constant voltage supply, using the improved control scheme, is highly efficient.

Adjustable voltage drives for blast furnace skip hoists are probably more efficient than many of the older magnetic contactor controls which, as above stated, were prone to excessive rheostatic losses. However, the adjustable voltage drive is not inherently efficient. The friction, windage, brush and iron losses of the necessary

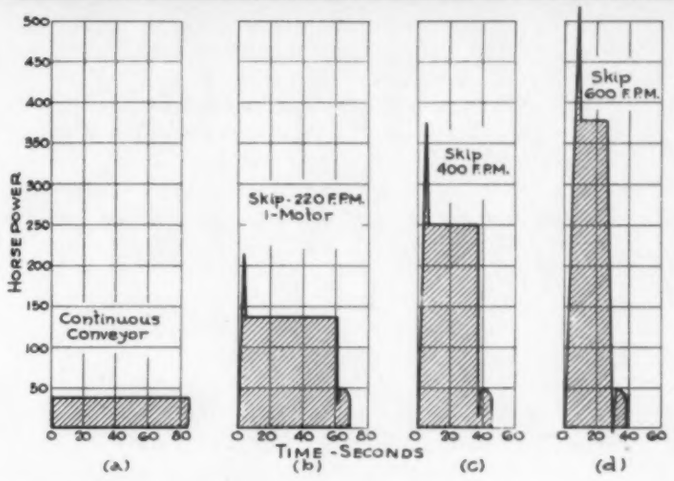


Figure 5 — Diagrams showing drive horsepower for skip hoists under various conditions.

motor generator set are of the general magnitude of 25 kw. These loom proportionately large when it is considered that a skip hoist is not ordinarily in movement more than one-third of the total time. During a considerable portion of the active period, the load is light. In relation to a job involving some 50 hp of useful work (continuous equivalent as indicated in Figure 5 (a), a standby loss of 25 kw is significant.

From the point of view of efficiency, the writer believes that, at plants where the blast furnace department is closely adjacent to other large consumers of direct current, such as unloaders, ore bridges and transfer cars, the most advantageous arrangement would comprise a rectifier supply of constant voltage in combination with improved series-parallel magnetic contactor control for dual-drive skip hoists.

Cost — The cost of a blast furnace skip hoist with adjustable voltage drive will generally run from 33 per cent to 100 per cent higher than a comparable hoist with constant voltage drive. The margin depends in considerable measure upon the amount of reserve equipment provided and upon the type of alternating current switchgear required for the motor driving the motor generator set. This margin is partially offset by the fact that some portion of the conversion capacity serving the blast furnace area should be allocated to the skip hoist operating on a constant voltage system. If a modern efficient hoist is used, operating at a moderate rope speed, this may be a relatively small item — of the magnitude of 25 per cent of the cost of the hoist. Diversity is a factor favorable to this arrangement.

In conclusion, the writer expresses the opinion that rope speeds not exceeding 400 fpm should be used for most blast furnace skip hoists. Such hoists can be handled satisfactorily and most reliably, efficiently and economically on constant voltage systems. The use of the adjustable voltage drive is preferable only where higher rope speeds are essential due to some special requirement, and where considerations relating to the direct current supply for the blast furnace area indicate advantages not directly related to the performance of the hoist itself.

DEVELOPMENTS IN

Corrosion Studies AND *Corrosion Control*

. . . . corrosion presents problems which must be faced, in some form or other, in every plant . . . . this compilation of the important literature on the subject will serve as a guide to references on the various phases of corrosion . . . .

by H. M. Olson

ADVISORY MAINTENANCE ENGINEER

THE OHIO SALT COMPANY

WADSWORTH, OHIO

▲ DURING the past ten years well over 3500 papers have been published and listed in trade journals, proceedings and other types of publications on various types of subjects pertaining to corrosion, its causes, control, etc. and many hundreds of others have been written and read at meetings but not published.

It was stated by a noted authority some years ago that the many articles written about corrosion indicate that we do not know too much about the subject. This may be true in a great many cases but good headway is being accomplished and practical field applications are showing fine results in actual practice. Also, the war has put new impetus into the matter of saving iron and steel equipment by controlling corrosion with its allied difficulties and some of the studies now being made will go a long way to help us prevent the great wastes in materials that have been caused by corrosion in both ferrous and nonferrous metals.

In the gathering of facts to be studied for this paper, over 500 papers have been abstracted and about 100 of these are listed in the bibliographical reference as an addenda.

The most interesting developments have been with the application of sodium hexameta phosphates, cathodic protection, silica gel, and the combination use of phosphates and sodium silicates.

From studies made it is apparent that the matter of corrosion can be divided into three groups, namely:

1. Corrosion due to atmospheric conditions.
2. Corrosion due to water conditions.
3. Corrosion due to soil conditions.

This paper will comment mostly on item No. 2, corrosion due to water conditions.

Speller states (1) a list of 15 facts established with respect to corrosion, particularly iron. Since this book was written many hundreds of investigations have been conducted in hundreds of plants and industries, which add many other pertinent facts and theories to what is already known.

The most important factors we are concerned with have to do with the action of oxygen and CO_2 mainly on the interior surfaces of water or steam distribution systems, but there are factors also to be considered relating to steam generation equipment, etc., with velocities of water flows, temperature of water (originally oxygen), temperature of ground around pipe or containers if buried and air around pipe if suspended, length of stagnant time, turbulency of flow, etc. total solids in water, calcium (magnesium) content, amount of CO_2, MO Alk (pH value) etc.

Speller states (2a) that iron, one of our base metals, is

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used in the ratio 18 to 20 to 1 as to nonferrous metals and in 70 per cent of the cases corrosion is a great problem.

Corrosion occurs where ferrous metals come in contact with water, main factors being free oxygen or oxidizing agents, metal surface films, temperature, composition of the solution, contact effects between dissimilar metals, rate of motion, and other factors effecting diffusion through the solution to the metal surface, diffusion being the main consideration.

Three types of exposure cause corrosion: atmospheric conditions, water conditions and soil conditions. In the atmosphere, excess oxygen, the degree of humidity and contamination of corrosive compounds such as sulphur dioxide are dominant factors. In water, free oxygen and metal surface films are controlling factors. Atmospheric and water conditions are not comparable. In soil, corrosion is characterized by electrolytic action, but may also include one or more factors found in air and water. In water, salt or fresh, low alloy steels have little advantage over carbon steels, and practically no difference has been found in various commercial types of carbon steel and wrought iron in either hot or cold water. Three per cent chromium steel shows less tendency to corrosion, and in cold fresh water where surfaces can be kept reasonably clean 18-8 steel shows little corrosion; however, in hot water there may be some corrosion. Oil and gas lines are often put in without protection against corrosion; hot spots are repaired as they show up. Recent studies made on pipe lines in the Everglades section of Florida show hot spots developing at certain places controlled in a large measure by the flow of water or moisture at the particular places. In water lines where we may have more uniform conditions that can be diagnosed, remedial measures can be made by:

1. Selection of more durable and thicker metals.
2. Interposing a protective coating between metal and liquid.
3. Treatment to form protective films, including cathodic protection.

Cost of corrosion 20 to 30 years ago was estimated at about 2 per cent of the tonnage in use but now with remedial methods in use the cost is practically negligible.

V. V. Kendall states (2b) that the materials used to be blamed for the corrosion troubles and failures; now we determine the corrosivity of the water and then analyze conditions. Corrosion is not a straight line function of time but there is a slow down in the rate of corrosion, dependent on service conditions. For atmospheric conditions, the increased resistance afforded by copper steel is well known; this resistance is due to the character of the rust coating formed. The rust coating on noncopper steel is porous and nonadherent, easily flaking off and offering no protection to the underlying metal. The rust coating on copper steel is dense, tightly adherent and is actually a protection. Figure 1 gives the corrosion time curves of a number of steels of varying copper content. In atmosphere, large excess of oxygen assists developing protective rust coatings; under water a limited amount of oxygen causes a decreased rate of corrosion. Figure 2 shows service tests in hot water lines in various cities with the rate of pitting plotted against period of exposure. Experimental conditions such as temperature, velocity of flow, etc. varied from test to test but it will be noted in spite of such variations that after 2 year periods and longer the points fall on a definite curve. After initial period of rust formation, rate of corrosion is slowed down and the attack on the metal is then dominated by the character of the rust, its porosity, its ability to permit diffusion of oxygen, etc. Figure 3 shows corrosion time relationship for 42 different soil conditions, and with the exception of poorly drained soils, there is a decrease in the rate of pitting with time.

Difference in materials used may be tied together as dissimilar metals effect galvanic corrosion conditions. Table I shows the galvanic series of metals and alloys in sea water. The metals and alloys have been divided into groups; within any group the materials may change places depending on the incidental conditions of exposure. Between groups, however, it would be unusual for changes to occur across the blank spaces. Metals grouped together have no great tendency to produce appreciable galvanic corrosion of each other. Connecting two metals distant on the list tends to corrode the one higher on the list. Nickel, Inconel and the stainless steels occur twice on the list, depending on whether they are active or passive in condition. Whether metals are active or passive is controlled largely by the aeration and acidity of the solution. The series indicates qualitatively how

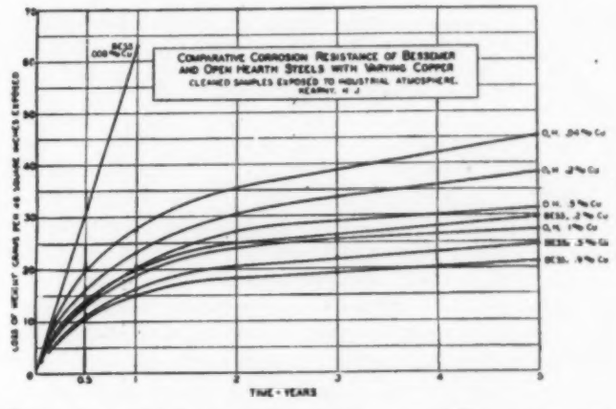
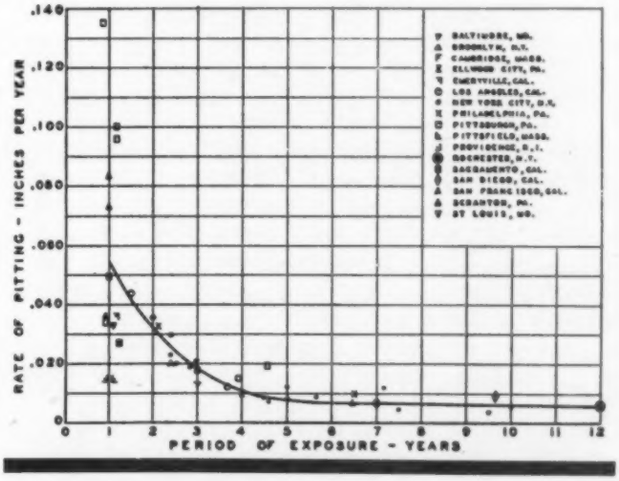

COMPARATIVE CORROSION RESISTANCE OF BESSEMER AND OPEN HEARTH STEELS WITH VARYING COPPER
CLEANED SAMPLES EXPOSED TO INDUSTRIAL ATMOSPHERE.
TIME - YEARS

Figure 1 — Corrosion time curves of several steels with varying copper content.

▲

Figure 2 — Graphs showing rate of pitting plotted against period of exposure for service tests in hot water lines.



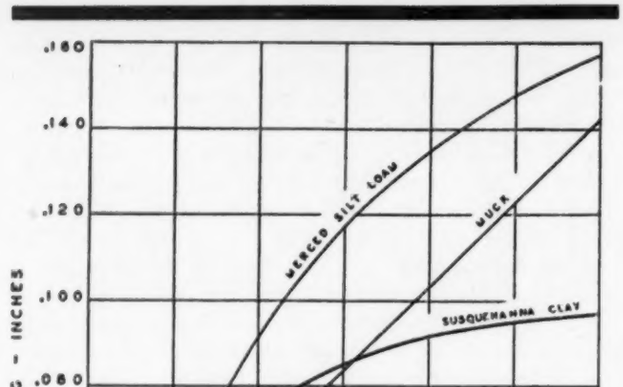


Figure 3 — Corrosion time relationships with different soils.

severe the corrosion may be. The intensity of galvanic corrosion will depend on the actual current flowing, which in turn will depend on the factors listed above. Where the area of the metal higher on the list is relatively small compared with the area of the metal lower on the list, trouble will be encountered. The reverse condition, that is, where the area of the first metal is large compared with the area of the second metal, is not likely to give trouble. For example, steel rivets cannot be used on a monel ship but Monel rivets can be used on a steel ship.

R. B. Mears states (2c) that, in the case of aluminum equipment, information is available on the use of electrical currents which are generated either by contact between sacrificial metal and the aluminum or where aluminum protects iron and steel, and information is also available for conditions where corrosion is due to external sources of current, such as dry cells, generators, etc. The position of zinc as compared to aluminum in the electromotive series shows aluminum higher on the scale than zinc, and it might be predicted that zinc is cathodic to aluminum. However in spite of this it has been found that, in most tap waters and also neutral salt solutions containing some chlorides, zinc usually has a solution potential which is about 0.2 volt anodic to that of commercially pure aluminum. Thus it is feasible to attempt to cathodically protect aluminum by zinc attachments. Details are given in the paper referred to above, with several examples on different types of equipment including ocean going vessels, etc.

K. H. Logan states (2d) the theories of cathodic protection, criteria for protection, methods of cathodic protection, types of installations, costs of cathodic protection and finally the use and application of cathodic protection in cities to protect distribution pipe lines which will be satisfactory if the networks can be interconnected and treated as a single system. Sufficient experience has been accumulated to show that cathodic protection of transmission lines is practical and economical. The failures have been attributed to poor design or poor maintenance of the systems. Windmills were installed in places where they could not supply power over sufficient periods, and some of the engines used to generate power could not carry their loads continuously. Such failures are to be expected in any pioneer undertaking and are not to be taken too seriously. Generating difficulties have been overcome to a large extent, although there is, however, need for data on the current densities and their effectiveness in order that greater economies may be effected.

Arba Thomas (2e) gives a general review of the role of bacteria in corrosion of iron and steel, the nature of corrosion bacteria, experiences in the field, methods of

TABLE I

Galvanic Series of Metals and Alloys in Sea Water

Anodic (corroded) end
Magnesium Magnesium alloys
Zinc Galvanized steel or wrought iron
Aluminum 52 SH Aluminum 4 S Aluminum 3 S Aluminum 2 S Aluminum 53 S-T Alclad
Cadmium
Aluminum A 17 S-T Aluminum 17 S-T Aluminum 24 S-T
Mild steel Wrought iron Cast iron
Ni-Resist
13 per cent chromium stainless steel
Type 410 (active)
50-50 lead-tin-solder
18-8 stainless steel type 304 (active) 18-8-3 stainless steel type 316 (active)
Lead Tin
Muntz metal Manganese bronze Naval brass
Nickel (active) Inconel (active)
Yellow brass Admiralty brass Aluminum bronze Red brass Copper Silicon bronze Ambrac 70-30 copper-nickel Composition G-bronze Composition M-bronze
Nickel (passive) Inconel (passive) Monel 18-8 stainless steel type 304 (passive) 18-8-3 stainless steel type 316 (passive)
Cathodic (protected) end

controlling bacteria, etc. Anaerobic bacteria have much to do with corrosion of iron and steel pipe in natural under-water and under-soil environments. These bacteria are not pathogenic and may be classed in two general groups, namely, sulphate reducing and iron consuming. Biologists have been well acquainted with their manner of living and their biological characteristics; their life processes, however have only been recently associated and correlated with the corrosion of iron and steel in under-water and under-soil service. Ordinary mineral analyses of water and soil have been used many times in an effort to determine their corrosivity to steel, yet there are cases on record where chemical analysis indicate noncorrosive conditions and actual service behavior was contrary to such preanalysis. Bacteriological examinations of the water, soil and corrosion products have brought out certain types of bacteria that contribute greatly to severe corrosion conditions. There are no data available to prove that these bacteria are directly responsible for the severe corrosive attacks, but even so their presence results in the formation of chemical compounds that either directly attack the metal or establish conditions conducive to electro-chemical attack. When these organisms are present in water, there are prescribed water treatments that will eradicate them, rendering the water inactive from a corrosion standpoint. The most common and inexpensive water treatments known today are the chlorine and chlorine ammonia (chloramine) treatments. These destroy the living bacteria and prevent growth and accumulation in pipe lines and other water handling equipment. Where untreated water is infested with these organisms, application of a good coal-tar base enamel coating to the metal is advisable.

Owen Rice (2f) sets forth typical applications of threshold treatments (threshold treatment being the addition of a few parts per million of sodium hexameta phosphate to water to overcome a wide variety of problems encountered in industrial and municipal treatment, as shown in Table II). Mr. Rice gives details on preventing (a) the precipitation of calcium carbonate upon the addition of alkali, (b) preventing the after-precipitation of calcium carbonate following lime and soda ash softening, (c) preventing the precipitation of calcium carbonate upon heating, (d) preventing the precipitation of calcium carbonate in recirculating cooling systems, (e) preventing the precipitation of dissolved iron from well water. He also goes into detail on corrosion control, coke plant condenser cooling water, copper blast furnace cooling water, cooling water for breweries, and municipal water supplies. He also gives conclusions showing the practicable application of this form of treatment in preventing the deposition of calcium carbonate.

TABLE II

Typical Applications of Threshold Treatment

- I. Prevention of the Precipitation of Calcium Carbonate.
  - A. Upon Addition of Alkali (to hard water containing bicarbonate.)
    1. Use of ammonia in irrigating water.
    2. Ammonia absorption system in by-product coke plant.
    3. Soda ash for internal boiler water conditioning.
    4. Caustic and hypochlorite bleach tanks in paper mills.
  - B. After - Precipitation Following Lime-Soda Softening.
    1. Boiler feed lines.
    2. Municipal water softening plants.
  - C. Upon Heating.
  - D. Upon Evaporation in Recirculating Cooling Systems.
    1. Power plants (low temperature.)
    2. Oil refineries (high water and oil temperatures.)
    3. Metallurgical furnaces (high skin temperatures.)
- II. To Prevent the Precipitation of Dissolved Iron from Well Water.
  - A. Upon Aeration.
  - B. Upon Heating.
  - C. Upon Chlorination.
- III. To Control Corrosion.
  - A. In municipal water distribution systems.
  - B. In recirculating cooling systems.
  - C. In brines.

William Stericker states (2g) the importance at this time of the use of corrosion prevention methods, going into details on the use of silicates with lead pipe, lead and ferrous metals. He also goes into detail on the theory of film formation, discussing the mechanism of formation, time of formation, forms of silica and kinds of waters that can be effectively treated.

Marc Darrin states (2h) that increasing amounts of water being used for air conditioning, washing, cooling and condensing raise a problem in many localities in respect to water supply and sewage disposal. Present practice tends to the use of recirculating systems to save water and the use of corrosion inhibitors to save metal in the systems. It is well known that the corrosion of many metals is greatly reduced by the presence of sodium chromate or sodium bichromate but there are almost no data showing the relative efficiency of these chemicals for the retardation of bimetallic corrosion in ordinary recirculating water systems. Comparisons are presented for iron, galvanized iron, tinned iron, copper, brass, and aluminum, both alone and in contact with one another. The corrosion of these metals in various water systems was greatly retarded or completely inhibited by sodium chromate at the concentrations indicated. For some combinations, sodium bichromate was equally satisfactory, but in general it was not so efficient as the chromate. In addition to prolonging the life of equipment, the formation of slime was avoided. The relative retardation of corrosion by sodium chromate is essentially the same in hot water as in cold water. Sodium chromate retains its inhibitive properties until lost from the system, either mechanically or by chemical reduction. For many practical purposes, its depletion may be judged by the loss of color.

H. L. Shuldener states (2i) that when a section of water piping in a building fails by corrosion it usually develops a leak, or it becomes clogged with its products of corrosion and ceases to deliver water. Nine most common troubles in apartment houses, hotel and office buildings are:

1. Change in temperature of hot water, as for example in a shower bath.
2. No immediate supply of hot water from the faucets.
3. Air sputtering from the faucets.
4. Poor flow.
5. Varying flow of water.
6. Rusty or so called red water discoloration from iron piping.
7. Blue green staining of white sanitary fixtures in brass or copper piping systems.
8. Lukewarm water at faucets which are being fed from a storage tank full of hot water.
9. Leaks.

Mr. Shuldener goes into details on each of these points

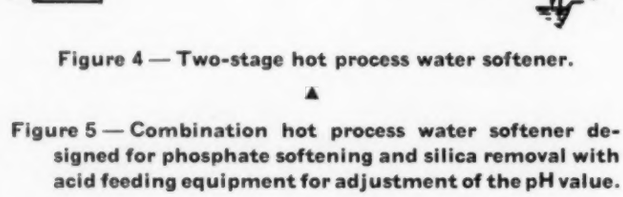
and suggests remedies that are safe and acceptable to the authorities of the city of New York health department. The following chemicals are allowed to be used for corrosion correction work; namely, sodium silicate, sodium carbonate, sodium bicarbonate, sodium hydroxide, sodium phosphate, calcium carbonate, calcium bicarbonate, calcium hydroxide.

C. E. Joos (2j) states in detail the benefits from the use of hot process water treatment methods, especially going into the matter of proper methods of obtaining corrosion-free water for boiler feed makeup, with details on the use of jet heaters instead of tray heaters for the elimination of oxygen and CO_2 from the water supply in order to protect steel tubes, economizers and boilers. He also gives details on the latest chemical methods and feeds for proper all-out chemical treatment which is desired now for high pressure boiler operations. Figures 4 and 5 illustrate proper layouts.

Figure 4 — Two-stage hot process water softener.

▲

Figure 5 — Combination hot process water softener designed for phosphate softening and silica removal with acid feeding equipment for adjustment of the pH value.



A_1 – $MgSO_4 + 2\,NaOH \rightarrow Mg(OH)_2 + Na_2SO_4$

A_2 $Mg(OH)_2 + SiO_2 \rightarrow MgO(OH)_2 \cdot SiO_2$

A_3 – $3CaSO_4 + 2\,Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3\,Na_2SO_4$

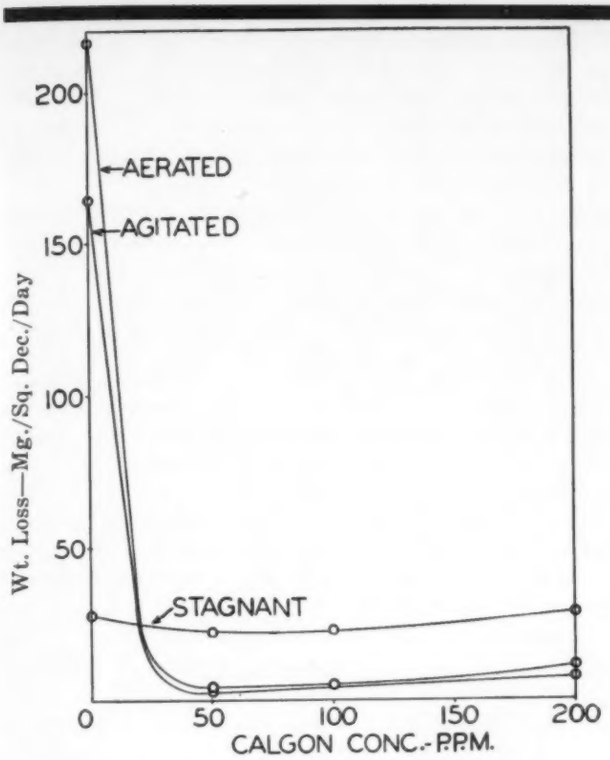
B – $H_2SO_4 + 2\,NaOH \rightarrow Na_2SO_4 + 2\,H_2O$

J. D. Yoder states (2k) that deaeration of boiler feed water generally implies the removal of oxygen which is the active agent of oxidation or corrosion of feed lines, high pressure heaters, economizers and boilers. Deaeration also substantially increases the pH value which is important because low pH accelerates corrosion. He concludes that deaeration of feed water not only removes oxygen, but also increases the pH value by removing CO_2. With efficient deaeration, CO_2 removed is greater than the amount commonly designated as free CO_2 because the carbonate radical CO_3 at any given alkalinity and pH value is not of importance from the standpoint of corrosion because this dissociation neither increases nor decreases the CO_2. The fact that such dissociation exists is important because it accounts for driving off with the steam a substantial amount of the CO_2 in the boiler. It also makes it possible by sufficient deaeration to increase pH of feed water substantially above 8.3. The more effective the degasification and the greater the dissociation of the carbonate radical, the more CO_2 is removed. It accordingly follows that the increase in pH value frequently becomes a better measure of good deaeration than the Winkler test for determination of oxygen. Performance curves of commercial installations are given in substantiation of these conclusions.

A. E. Kitteredge states (2l) that the removal of dissolved gases from boiler feed water does not increase efficiency or capacity, and does not reduce the first cost of the plant but gas removal is vitally necessary in one manner or another, and pays high returns on the capital invested for that purpose in the form of protection for almost every other single piece of equipment in the steam power cycle. The technical and chemical phases as well as the physics of feed water heating is covered in what is a very complete treatise on the subject.

R. B. Mears describes, in "The Use of Inhibitors for Aluminum Chemical Equipment," (3a): a classification of inhibitors including sodium chromate soluble oil No. 1 and soluble oil No. 2, according to their effectiveness and their influence on the intensity and area of attacks, with many details on chemical laws and formulas using acid, alkaline as well as neutral solutions and tap waters in the tests conducted. He describes also the prevention of galvanic action by the use of inhibitors. The electrochemical behavior of inhibitors is discussed and the factor that causes an inhibitor to be safe or dangerous is outlined. Organic substances, as well as soluble oils, alkaloids and organic sulphur compounds, proved to be effective inhibitors in hydrochloric acid. Chromates, soluble oils and commercial wetting agents appeared to be best in sulphuric acid. In alkaline solutions, the silicates were the most promising inhibitors. Chromates and soluble oils were the most effective inhibitors found for nearly neutral solutions. Even these substances were not effective, however, for preventing galvanic attack by waters containing appreciable concentrations of chlorides.

F. N. Speller states (3b) many different ways to use



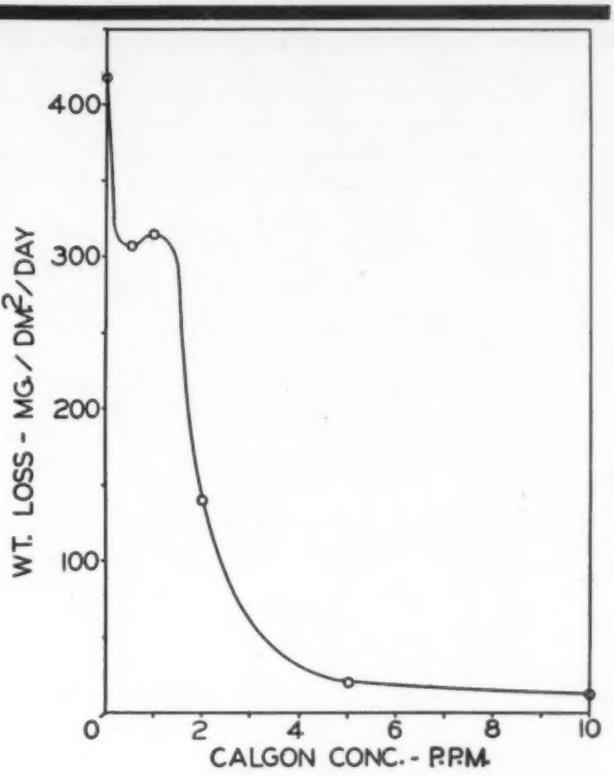
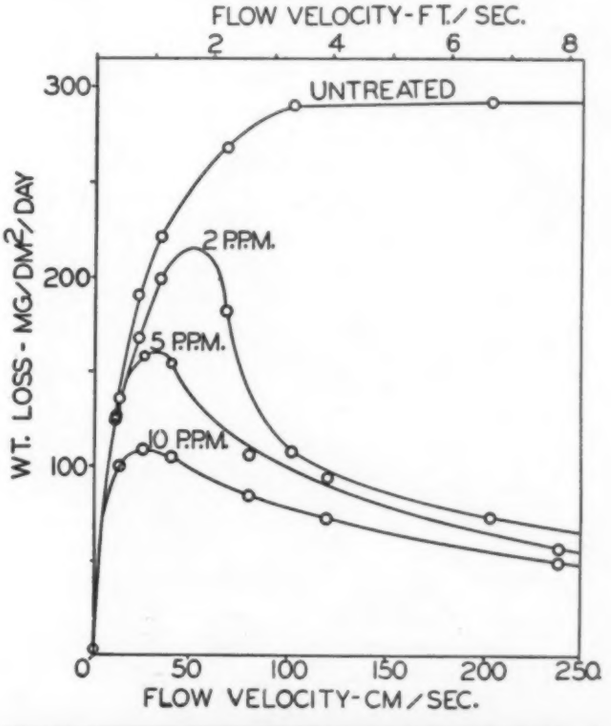


Figure 6 — Chart showing effect of calgon on corrosion using a specimen submerged in one litre of water. Ordinate is milligrams per square decimeter per day. (above left)

Figure 7 — Chart showing effect of calgon on corrosion using a larger solution sample of 20 litres. (above right)

Figure 8 — Chart showing effect of calgon on corrosion under continuous flow conditions. (below)



paints or other covering for under-water protection, and goes into detail on tests conducted at Lorain, Ohio and also at the Panama Canal Locks.

Owen Rice states (4a) that experimentation with and use of inhibitors has been greatly stimulated by war conditions because corrosion conditions can no longer be alleviated simply by replacement with more resistant metals. Even galvanized iron pipe cannot be obtained, and consequently it has become necessary to get along with black iron and steel pipe. In using this type of pipe where common forms of red water and corrosion troubles are present, some kind of solution has to be used to prevent frequent replacements, as it is impossible in most cases to provide deaeration. A solution of sodium meta phosphate is then used, the amounts depending on conditions to be met. Description of various recent experiments were given including effects of agitation, temperature, flow rates, concentration of phosphate used as shown in Figures 6, 7, 8, 9, and 10.

Robert C. Adams (4b) gives methods used by the U. S. Navy in making tests on feed water heaters that are used on ships in Navy service. Mr. Adams goes into technical details on how the tests are conducted, etc. The interesting feature is the discussion by the manufacturers on the conditions that have to be met on the test to satisfy Navy requirements.

A. E. Griffin (4c) shows the effect of bacteria, fungi, hydrogen sulphide, water quality, and bacteria food, in anaerobic corrosion. Mr. Scott also gives comments on corrective measures to be used, and describes the plant practice and chemical control required. Interesting comments by C. D. Adams on his experiences at New Albany, Indiana, with this type of corrosion are given in the discussion.

L. F. Collins states (4e) that it has been demonstrated that dissolution of CO_2 in condensate in amounts up to

that mixed in the incoming steam can and sometime does occur in operating steam heating equipment. He shows that even low concentrations of dissolved CO_2 can produce active corrosion if other contributing factors are optimum. However, the copper alloys, which up to now have been most commonly used in lieu of ferrous materials, are immune to attack. It is common knowledge that as yet no method on a commercial basis has been developed by which steam can be produced entirely free from deleterious gases, when large quantities of carbonate-bearing feed waters are used, and because of economic reasons, the materials shown to be immune to attack cannot be used upon a broad scale. If this is a valid appraisal of the situation, then it is clear that the complete solution of the general problem of steam heating corrosion is not yet in view. It is Mr. Collins' view that the status quo will not change perceptibly until research work of a fundamental nature has been done. The paper includes in detail published data, studies of the mechanism of dissolution of CO_2 in steam condensing equipment, experimental technique, results obtained, tests of the comparative corrosion resistivity of several metals, new test apparatus, technique in present tests, materials tested, cleaning of the test specimens, summary of corrosion controlling features, results obtained, and significance of the results. Figures 11 and 12 are of interest in this paper. S. F. Whirl has interesting comments on this subject covering his experiences with the Duquesne Light Company, with an interesting diagram as shown in Figure 13.

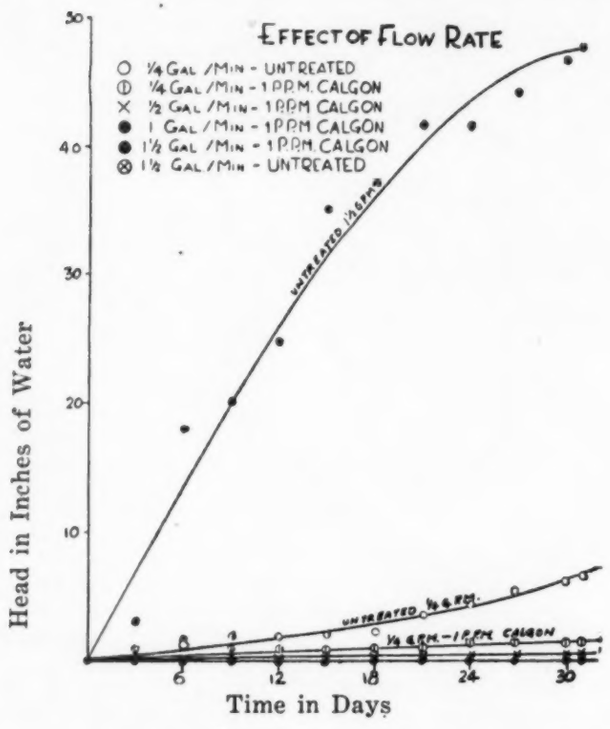
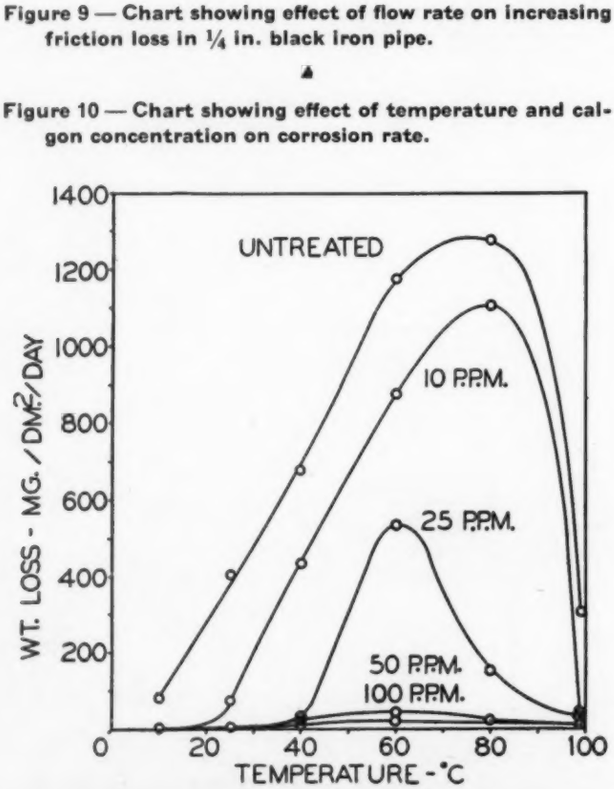

EFFECT OF FLOW RATE
○ ¼ GAL /MIN - UNTREATED
① ¼ GAL /MIN - 1 P.P.M. CALGON
× ½ GAL /MIN - 1 P.P.M. CALGON
● 1 GAL /MIN - 1 P.P.M. CALGON
● 1½ GAL /MIN - 1 P.P.M. CALGON
⊗ 1½ GAL /MIN - UNTREATED
UNTREATED ¼ & 1 GPM
UNTREATED ½ & 1 GPM.
½ & 1 GPM - 1 P.P.M. CALGON
Head in Inches of Water
Time in Days
10
20
30
40
6
12
18
24
30

Figure 9 — Chart showing effect of flow rate on increasing friction loss in ¼ in. black iron pipe.

Figure 10 — Chart showing effect of temperature and calgon concentration on corrosion rate.



L. P. Sudrabin states in his article "Cathodic Protection of Steel Equipment Submerged in Water" (5th Annual Proceedings — Water Conference — Engineers Society of Western Pennsylvania, 1944) that cathodic protection consists of stifling the flow of current which accompanies electro-chemical corrosion by superimposing a current flow through the corroding media to the surface to be protected. This article describes the first application by Davy (1824) gives a history of the development of cathodic protection, and compares cathodic protection with other means of corrosion control. The idea is old but the application is new. The article describes chemical corrosive mechanism, states minimum current density requirements with formulas, discusses dissolved oxygen concentration and the need for protection against corrosion, as well as anode design and sources of protective current with operating costs. An engineering survey must be made to determine the minimum current density required, and to provide proper anode design and current source for any particular corrosion problem.

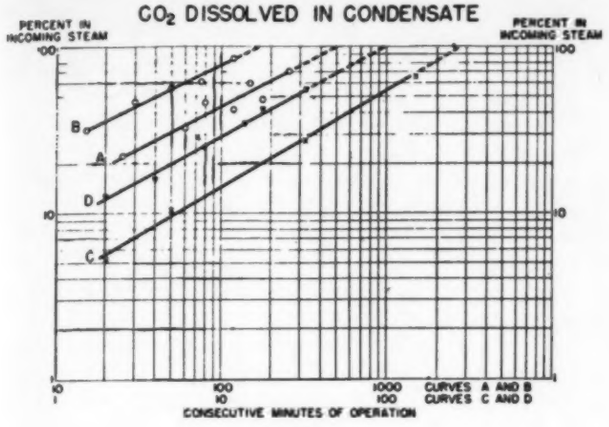
C. W. Borgmann states (97) that corrosion of metal in a water will be of one of these three types:

1. General attack, where conditions are severe and the entire area breaks down, with fairly uniform rusting continuing under a porous layer of corrosion products.
2. Under less severe conditions, as in soft natural waters to which have been added sodium hydroxide in critical amounts, only the weakest areas are attacked with resulting pitting.
3. The environment is such that a perfectly protective film is formed on the metal and corrosion is stifled completely by its products.

These types are dependent on the following factors:

Solution:

1. Character and concentration of dissolved substances.
2. Temperature.
3. Movement of solution relative to metal.
4. PH of solution.



KEY

CURVE		A	B	C	D
CONDENSER		1	1	2	2
CONDENSING RATE lb per hr at 5 lb gage		3	7	100	200
CO_2 IN INCOMING STEAM parts per million by weight		18	18	38	23
TOTAL CO_2 TO SYSTEM lb per hr per cu in of steam space x 10^8		18	43	75	90
TIME TO REACH EQUILIBRIUM minutes, approximate	CALC	1100	500	700	295
	EXP	500	170	280	100

Figure 11 — Time rate of dissolution of CO_2 in condensate for unvented condensers.

Metal:

1. The state of surface film (number of susceptible points).
2. Type and geometrical location of corrosion product formed.
3. The existence of crevices, porosities and shielded areas.

T. E. Larson and Dr. A. M. Buswell (5) state that $CaCO_3$ solubility equilibrium is highly important in many phases of water chemistry. It is directly associated with scale formation in many types of equipment from tea kettles to boilers and boiler feed water heaters, and with incrustations of well screens, filter sands, meters and water taps. Equilibrium balance is affected by many natural reactions in water, before, after and during treatment, as follows:

1. Photosynthesis in surface supply reservoirs removes CO_2, resulting in an increase of pH which has been known to precipitate $CaCO_3$.
2. Aeration of well waters, loss or absorption of CO_2.
3. Treatment with coagulant to free CO_2.
4. "Air Binding" in filters, due to pressure drop, tends to draw out CO_2.
5. Chlorine treatment and deaeration.
6. Anti-corrosion treatments by lime, soda ash, silicates, chromates or phosphates.
7. Bacterial growths in mains may consume CO_2 or in some cases produce CO_2.
8. Bacterial action can convert basic ammonia actions in acidic nitrites or nitrate ions.
9. Corrosive action itself produces hydroxyl ions.
10. Change in temperature.
11. Many others.

G. B. Hatch advises (6) that tests with lead, as with other more common metallic materials of construction, show that corrosion protection obviously is attained by the formation of a resistant coating or film upon the metal surface. Protective film formed upon the lead by phosphate concentrations of one to two ppm and probably even lower is effective in reducing the pickup of lead from the metal surface.

Starr Thayer reports (7) that, in buried pipe lines, loss of metal is due to:

1. Electrolysis from stray currents.
2. Long line currents which enter in one place and leave another.
3. Soil corrosion because of the composition of the surrounding soil.

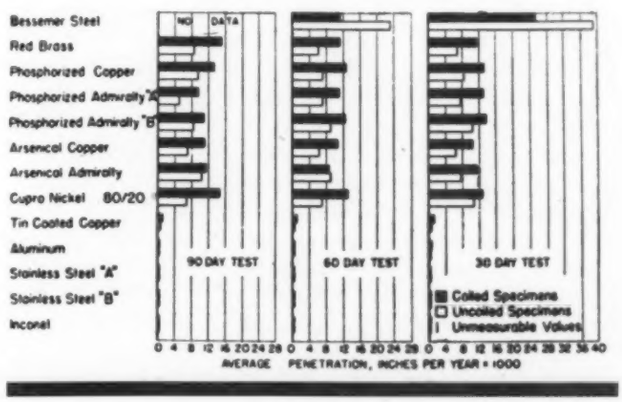
Other comments on buried lines:

1. Drain wires back to source will reduce corrosion.
2. Currents which are small do not cause much trouble in themselves.
3. Protective coatings when laid will eliminate troubles.
4. Currents generated in pipe itself will flow in the pipe walls to areas where they discharge into the soil.
5. As the current leaves the pipe it takes metal with it.
6. Currents are small and generally are discharged in a small area.
7. One ampere continually leaving pipe wall will take 20 lb of metal with it within a year, so if confined to a small area will do a lot of damage.
8. Principle cathodic protection is this: A current is caused to flow from the surrounding soil into the pipe in sufficient strength to offset these currents that are trying to leave the pipe. When this is done corrosion will cease. D-c current is used, with the positive terminal connected to a mass of steel junk buried nearby and the negative terminal to pipe.

Deming Bronson states (8) that the question of steel pipe protection is primarily an economical one. Interior coatings are:

1. Galvanized inside protection.
2. Galvanized coating supplemented by special chromate treatment.

Figure 12 — Comparison of corrosion rate on various metals.



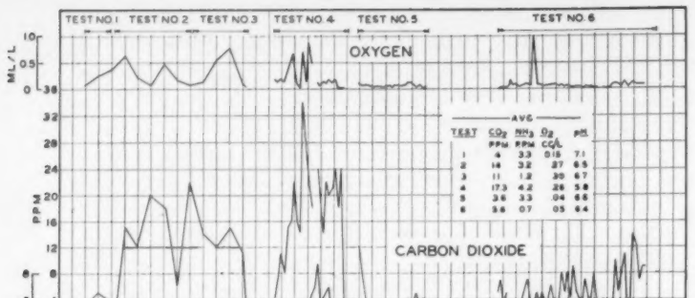


Figure 13 — Analytical data from corrosion tests on different metals in steam and steam condensate.

3. Cement lining with low lime, high silica content, and low solubility properties applied centrifugally and cured properly.
4. Two coats of liquid tar-coal solution.
5. Hot dipped asphalt bath.
6. Hot spun tar primer, sprayed or brushed on the pipe then spun to get uniform coating.

Exterior coatings are:

1. Red lead or aluminum paint (for pipe exposed to air).
2. Galvanized.
3. Hot asphalt dip (with white wash or kraft paper covering on outside to prevent sticking or running from heat by sun).
4. Asphalt (as was done on the Big Inch) with wrappings of organic or inorganic materials.
5. Coal-tar enamel with or without wrappings.

George D. Norcom gives (9) a summary of two main factors which determine the progress of corrosion of iron in water from Speller:

1. "The element iron, like all other metals when placed in contact with water — has definite inherent tendency to go into solution — as the iron goes into solution, hydrogen is plated out as a thin invisible film on the iron surface."
2. "If corrosion is to proceed, the hydrogen film must somehow be removed. This happens mainly in two ways: (a) the hydrogen combines with oxygen present in solution to form water, or (b) it may escape as bubbles of hydrogen gas."

Norcom continues to consider a corrosive water. From an empirical standpoint the following can be used as a guide:

Factors favoring corrosion:

1. A high oxygen content.
2. A high content of free CO_2 particularly in soft water.
3. The greater the hydrogen in the concentration, the more active will be the corrosion.
4. The presence of high chlorides.
5. High velocity with turbulence.

Factors retarding corrosion:

1. Corrosion is less severe in hard waters (sulphates).
2. The presence of considerable organic matter, particularly high color.
3. Higher alkalinity, more especially the presence of normal $CaCO_3$.
4. The presence of rust, films or protective coatings on the metal surface.

Thomas M. Riddick states (10) that the factors in reducing corrosion are:

1. Low non-carbonate hardness or low sulphate content.
2. High alkalinity.
3. High silica content.
4. Low CO_2.
5. Low oxygen concentration.
6. Low temperature.

H. A. Knudsen states (11):

1. Corrosion is caused by gases, oxygen and CO_2.
2. Tuberculation is one of greatest sources of trouble in distribution systems and is a combination of corrosion and incrustation, the extent of corrosion is minor, producing only small pits or corroded areas under the tubercles. Tubercles resemble barnacles and may build up so as to entirely close a pipe. Some theories are that tubercles are formed by an iron consuming or iron depositing bacteria, crenothrix.
3. Dezincification, where zinc is removed from the copper-zinc alloy. The theory of the mechanism of dezincification assumes that brass dissolves as a whole, the dissolved copper being held in contact with brass by a membrane while the copper is redeposited, leaving a spongy mass of copper.

Robert E. Ashline (12) states that corrosion is due to:

1. Stray currents or electrolysis (rare).
2. Corrosive water and tuberculation.
3. Poor galvanizing (zinc-iron electrolytic couple).
4. Dezincification of brass pipe (micro galvanic corrosion).
5. The use of dissimilar metals (galvanic actions and thermocouple effect).
6. Use of water softeners (electrolytic concentration cells).
7. High pressure velocity flows of water which dislodge the protective scale to corrosive attack.
8. Leaking of refrigerant at joints and connections (acid attack on metal). The paper gives the remedies in each case listed above.

Speller and Kendall (13) give us factors dealing with corrosion in soils, etc. as follows:

Soil factors inducing corrosiveness:

1. Poor aeration.
2. Fine or close texture (clay).
3. High average moisture content.
4. Low electrical resistivity.
5. Acidity (a) high hydrogen ion concentration (b) high total acidity.
6. Presence of sulphides.
7. Reduction of sulphates by anaerobic bacterial action.

Soil factors retarding corrosiveness:

1. Good aeration.
2. Coarse and open texture (clay).
3. Low average moisture content.
4. High electrical resistivity.
5. Alkalinity.
6. Presence of $CaCO_3$.
7. Presence of soluble silicates.

Full details are given covering a large scale study of

soil corrosion by the National Bureau of Standards. Under heading "Corrosion of Lead, Copper and Brass" is stated:

1. High concentrations of dissolved salts favor passage of electric currents, and electrolysis which results and introduces into the water, metals derived from pipe and fittings.
2. On the other hand, waters which are relatively free from dissolved material are eager to dissolve substances with which they come in contact, and for that reason distilled water is corrosive to metals.
3. Water containing suspended solids are apt to erode the materials it comes in contact with.
4. The longer the water stands in the pipe, the greater is the dissolving action, while high velocities are most objectionable as they increase erosion.
5. Waters which are corrosive, or which erode materials obviously cause difficulty in boilers, heaters, valves, and fittings. Alkalinity may accelerate the cracking of metal around rivet holes in boiler plate, while the presence of certain other salts in given amounts inhibits the cracking.
6. Concentration of solids causes foaming and starts priming.
7. Gases other than CO_2 and oxygen also have an action; for example, hydrogen sulphide is destructive and forms a brittle ferrous sulphide on the surface of iron exposed to it.
8. When ammonia is present in an alkaline water it will volatilize by heat and corrode copper and the copper in brass and bronze.
9. Highly alkaline waters will dezincify.
10. Chlorine is a corrosive gas but usually the small amounts used are consumed by organisms in the water.

Expendable magnesium anodes are now being used to great advantage in cathodic protection of pipe lines with a life expectancy of 10 years.

An A. W. W. A. committee report (15) states:

1. In ferrous metal piping systems, the use of metaphosphates will nearly always eliminate, or at least minimize, the outward manifestations of corrosion, particularly red water and tuberculation. This conclusion is largely derived from operating experience and is substantiated in laboratory studies.
2. Conflicting evidence as yet forbids a definite statement as to whether metaphosphates do or do not prevent actual corrosion of ferrous metals, using term corrosion in the sense of removal of metal from a surface. The members of the committee are not in agreement on this question.
3. The effectiveness of metaphosphate in preventing attack on nonferrous metals seems to depend on the metal and on the particular aspect of the corrosion studied. Prevention of precipitates of metal salts and of stains on fixtures seems to be well authenticated. The prevention of penetration and pitting by metaphosphate is at present in doubt in the case of copper, brass and zinc. The action of metaphosphate on lead is to reduce the amount of lead taken by waters of pH value lower than 7.0, and possibly to increase it slightly in waters of pH value greater than 8.0.
4. Disturbances in water systems produced by the addition of metaphosphates, such as sloughing off of scale deposits on pipe and increased bacterial counts, does not seem to be sufficiently common to cause concern, but abrupt changes in pH value should be avoided when metaphosphate treatment is introduced.
5. Metaphosphate has been used to advantage in conjunction with other chemicals for corrosion control, such as lime, soda ash or caustic soda. Of these lime is the one generally used. In such combined treatments, the metaphosphate provides an additional benefit by preventing deposition of calcium or magnesium salts in the system, particularly in hot water coils or piping.
6. On the basis of chemical cost only, metaphosphate treatment appears more expensive than most other forms of anti-corrosion treatment; however, when lime treatment and metaphosphate treatment are compared, attention must be given to the cost of additional soap used by the consumer if lime treatment is adopted. Other benefits secured by metaphosphate treatment, such as the prevention of red water and tuberculation must also be considered.
7. In connection with the action of metaphosphate in preventing red water, it is noted that this chemical may be used to prevent the precipitation of iron and manganese in water.

Everett P. Partridge, in his excellent chapter on corrosion and its control (16) in TAPPI Monogram Series No. 1, 1942, discusses in full detail types of corrosive attacks, general attack, dezincification, localized attack, pitting, stress corrosion, intergranular corrosion, theory of corrosion, steel in acid solution, steel in a natural water supply, steel in hot concentrated caustic alkali solution, control of corrosion, the metallurgical approach to corrosion control, the mechanical approach to corrosion control, the electrolytic approach to corrosion control, the physical approach to corrosion control, the chemical approach to corrosion control and the approach to a specific problem.

G. H. Mantillon (17) states that in order to understand the various factors involved in the cathodic protection of underground structures and tanks it is necessary to understand the nature and mechanism of the corrosion that makes such protection necessary. He reviews theories advanced by many of the better authorities and has an extensive bibliographical reference list.

Irving L. Dahljelm in an article (18) states a very true fact that is not given proper consideration in this matter of corrosion and it is this: "A review of the work of the past and present leads to the conclusion that each phase of the problem must be considered individually and that much study and experimentation must be undertaken before any real solution to the problem, as a whole, is found."

Ryan's book (19) has several very good chapters on corrosion, and how to take care of it. He goes into the theoretical as well as the practical side of the problem, stating reactions that take place when various types of chemicals are used. Ryan's book also has an extensive bibliography. He shows alkalinity curves as well as an oxygen saturation curve and sketches on several types of equipment that can be used to feed chemicals, etc.

LaMotte, Kenny and Reed's book (20) is perhaps the best book written on details of pH, its control and how it is to be used in water as well as other forms of treat-

ment requiring pH control. The chapter on water corrosion problems is very complete.

Lewis B. Miller has a rather extensive review on water (21) with a review chapter on corrosion in which he states the situation as far as corrosion is concerned: "The subject of corrosion is so broad and the literature is so extensive that only the merest outline of some of the phases in water can be given." He has a bibliographic reference of late articles including many of those reviewed in this paper.

One of the best books on the subject is "Water Purification for the Practical Man" (22), by C. R. Cox of the New York State Department of Health. This is a handbook of laboratory practice in the water works plant, prepared particularly for the man who has not had the advantages of extended training in chemistry and bacteriology. The book has a good chapter on corrosion and its correction, as well as a good index.

Larson, in his book (23) "Pipe Corrosion and Coatings," goes into the theory on pipe line corrosion and also into the various means of properly coating a line to protect it against corrosion, stray currents, etc. The book has chapters on soil analysis, corrosion measurements, and extensive details on proper paints and how they are to be applied, as well as a chapter on cathodic protection.

Powell, in his book (24) "Boiler Feedwater Purification," deals thoroughly and extensively on all matters pertaining to his subject; with chapters on deaeration of feed water, corrosion — its causes and cure, and embrittlement of boiler metals, as well as chapters on the uses and application of standard chemical treatments and boiler compounds. In the chapter on corrosion he goes into the theories advanced at various times on the causes of corrosion: the acid theory based on the factors, acid, water and oxygen; the peroxide theory of 35 years ago; a supposed continuous action theory; the colloidal theory of 20 years ago; an electrochemical theory by Whitney of 40 years ago; and information on up-to-date theories with data on corrosion in boilers, heaters, and some information on hydrogen corrosion.

Bulletin No. 8 (25) issued by the Solvay Process Company covering "Alkalis and Chlorine in the Treatment of Municipal and Industrial Water" has a chapter on corrosion control with methods of making required tests, as well as some information and tables to use in connection with the Langelier corrosion index formula.

Charles P. Hoover (26) gives a very interesting discussion going into the practical application of the use of the Langelier corrosion index in a special leaflet that he has published. He gives practical methods of using the index and includes a nomograph to simplify the use of this rather complicated formula. Some modifications have been made on the use and application of the original formula that clear up some of the points of the original formula that were not entirely correct.

Hardenbergh in his book "Water Supply and Purification" (28) has a chapter on corrosion showing relation between pH value and alkalinity and relations between carbon dioxide content and alkalinity. He also shows methods of calculating the proper chemical dosages.

The Permutit Company's new 1943 Water Conditioning Handbook (29) is the last word on water conditioning and has many points of information on corrosion and how it is to be overcome in municipal, industrial and institutional applications. It also gives data on feed water heaters and on the elimination of corrosive tendencies of waters, as well as a rather extensive chemical reaction section.

In an article entitled "The Analytical Control of Anti-Corrosion Water Treatment," by Prof. W. F. Langelier (27), a formula was proposed for calculating the pH of any water at the saturation point of $CaCO_3$, which gives an idea as to whether the pH of a given water is above or below the saturation pH, and this indicates whether a water tends to deposit or dissolve calcium carbonate. The chemical background in the determination of the Langelier index is somewhat complicated. If temperature, total solids, calcium, alkalinity and pH of a water are known, it is possible to arrive at the pH of the water for complete saturation with calcium carbonate.

A chapter on corrosion appearing in the 1940 Heating, Ventilating and Air Conditioning Guide (32) goes into detail on the effects of oxygen, electrical stray currents, CO_2, and electrolytic currents, and lays particular stress on corrosion in return steam lines, etc. Sodium silicate with oil has been used to some extent to overcome corrosion in return lines.

Palmer's paper "Corrosion as Related to Air Conditioning Equipment (33) concludes that characteristics of water vary widely; certain waters are scale forming while others are corrosive; waters often bring about high rates of depreciation of apparatus and lower operating efficiencies; chemical analysis of the waters used followed by chemical conditioning will obviate the many difficulties encountered.

H. L. Shuldener (36) goes into details on what happens when dissolved gases ruin plumbing, and gives typical illustrated cases dealing mainly with iron, brass and copper pipe installations. He also describes dezincification, green copper stains and gives data on what type of metal should be used in pipe distribution systems.

Mears and Brown (37) go into detail on "Causes of Corrosion Currents," in a very complete article with illustrations, stating that localized attack of metal specimens is often the result of electrochemical corrosion, not of simple chemical solution. The appearance of specimens suffering from this type of attack has led laymen to attribute the corrosion to the presence of impurities in the corroded metal. However, impurities are only one possible cause for this type of attack.

Other known or possible causes are: (1) grain boundaries, (2) orientation of grains, (3) differential grain size, (4) differential thermal size, (5) surface roughness, (6) local scratches or abrasions, (7) difference in shape, (8) differential strain, (9) differential pre-exposure to air or oxygen, (10) differential concentration or composition of the corroding solution, (11) differential aeration, (12) differential heating, (13) differential illumination, (14) differential agitation, (15) contact with dissimilar metals, (16) external applied potentials, and (17) complex cells. In cases encountered in practice items 4, 6, 10, and 11 appear to determine the local sites of attack more frequently than do any of the other causes.

The magnitude of potential differences generated by

the several causes listed have been determined experimentally and are given in the paper. In several cases examples illustrating the special attacks resulting from these causes are described.

A reprint of an article in Steel (38) describes a new method of corronizing steel with a metallic coating that works well with corrosive hydrogen sulphide and salt brines and is used in manufacturing processings by many of the larger steel companies.

An interesting article, "Corrosion of Steel by Dissolved Carbon Dioxides and Oxygen" (39) by Skaperdas and Uhlig goes into detail on previous investigations and manner of conducting tests with the theories involved. It concludes that controlled laboratory tests indicate that both dissolved carbon dioxide and oxygen in steam condensates can be effective causes of causing failures in return pipes and that the oxygen is relatively 5 to 10 times more effective than equal concentrations of carbon dioxide. When corrosion is caused largely by dissolved carbon dioxide, the structure and composition of the steel are factors in determining its life.

Probably one of the best sets of articles is, "Corrosion in Steam Heating systems," by L. F. Collins and E. L. Henderson and published in Heating, Piping and Air Conditioning. These articles include the following:

1. Occurrence of Corrosion in Operating Steam Heating Systems.
2. Dissolved Gases — The Basic Causes for Corrosion — Part No. 1.
3. Dissolved Gases — Part No. 2.
4. Methods of Reducing Corrosion Troubles.
5. Eliminating Deleterious Gases from Steam.
6. Removal of Carbon Dioxide by Feedwater Treatment.
7. Removal of Gases from Feedwater.
8. Feedwater Treatment Systems in Central Heating Plants — Part No. 1.
9. Feedwater Treatment Systems — Part No. 2.

The articles have bibliographical references and are based on 15 years work at the Detroit Edison Company, Detroit, Michigan.

Eliassen and Sutherland (41) report on the use of "Sodium Hexametaphosphate Tested for Corrosion Control" and state that, with New York City water, results were very satisfactory with about 2 ppm, but that with lower pH values the dosages had to be increased.

C. D. Adams in a paper "Calgon — Its Uses and Limitations" (42) states that anyone contemplating its use should get answers to the following questions:

1. How much Calgon need be fed?
2. How shall it be fed?
3. Where shall it be fed?
4. How much will the treatment cost?
5. Will the treatment be successful?

He goes into details on each of the above questions and concludes with a very good outline on the limitations of the use of Calgon.

Chas. P. Hoover has done a good job in an article (43) on the subject of "Cement Lining Salvages Hot Water Tanks." He goes into details on just how to build and operate the needed equipment to take care of salvaging hot water tanks that have been taken from the scrap pile. The tank is spun so that the cement will adhere in a uniform coating that will stay put, however, a special heat transfer system has to be used in the bottom of the tank to prevent the breaking away of the cement in the bottom of the tank.

The magazine Betz Indicator, May 1943, (44) has a very fine article on deaeration which goes into full technical details on the mechanics and chemistry of the process, and the application of mechanical equipment. He concludes that the production of a deaerated water of "zero" oxygen content is not physically possible, although the dissolved oxygen content may be reduced to a value below that detected by chemical test. Since an absolute "zero" oxygen in a deaerator effluent is not possible, any specification for "zero" oxygen feed water must be qualified for the specific test to be employed in measuring oxyg n content.

"Quantitive Effect of Dissolved Oxygen and Carbon Dioxide on Corrosion of Steel," by Finnegan and Jacobus (45) states that the corrosion rate was a function of the oxygen and carbon dioxide concentrations. This relation is established in a series of curves. One ppm of dissolved oxygen is approximately as corrosive as 20 ppm of dissolved carbon dioxide, and at zero concentration of either gas the corrosion rate is not zero but a value dependent upon the concentration of the other gases.

A. A. Hirsch (46) describes in detail a continuous calcium carbonate balance indicator which is an amplification of the Enslow tube. The indicator has additional provisions which include: (1) sufficient length of packed column to ensure equilibrium for the water under test; (2) an internal filter to prevent power carry-over; (3) a companion unpacked column, or synchronizing tube, to preserve proper time relationship between the original water and its stabilized counterpart. (This is especially applicable for rapid changing supplies); and (4) a continuous emf indication by means of an integral concentration cell.

D. W. Haering in an article (47) "Experimental Cooling Systems — Design, Construction and Operation, with Scale and Corrosion Studies," goes into full details covering scale, corrosion and living organism factors affecting the life, maintenance and efficiency of cooling systems. He gives critical dissolved solids limits in scale control, the relative effectiveness of both scale and corrosion inhibitors, and the effect of chloride ion concentration on corrosion rates.

Geo. D. Norcom's article, "An Outline of the Corrosion Problem in Water Works" (48), goes into a very interesting discussion on corrosion theories, effects of corrosion, relation of quality of water to corrosive action, corrosion prevention, control of corrosion by water treatment, including mains, service pipe, standpipe and steel tanks, meters, valves and appurtenances. He concludes that in spite of the study that has been given the corrosion problem, it is still apparent that it is a long way from being solved.

The bulletin prepared by the D. W. Haering Company on "Organic Methods of Scale and Corrosion Control" (49) goes into detail on the uses of various forms of glucosates and glucosides as well as the tests involved.

An interesting study of corrosion has been made under the author's guidance and observation at the New Philadelphia, Ohio, municipal water plant since its construction about 9 years ago. The original setup did not include any form of treatment or correction of the

pH value of the distributed water to prevent the red water or corrosion troubles that might lie ahead. The plant consists of a ripple aerator with two gravity type synthetic zeolite water softeners. Part of the raw water, which has an original hardness of about 22 grains per gallon. The distributed hardness is about 5 grains, with 1.0 to 1.5 ppm of iron and a trace of manganese in the raw water. The pH of the raw water after it was put into the distribution system was about 7.3 with the calcium carbonate equilibrium about 7.9 pH. Soon there appeared to be a great deal of stoppage in the meters and about one-third of them were out of service or not working when readings were taken. Then an orifice type feed was installed to feed soda ash to raise the pH to the proper equilibrium point. This went along for some time but the operator stated that the water did not have suitable taste at pH 7.9, and so reduced the pH with the consequence that corrosion and deposits in the meters again appeared. It was then suggested that sodium metaphosphate be fed, and this was done in the fall of the year. At first it worked nicely, but about that time of the year, an algae growth appeared in the supply and there was an extensive display of green growths floating on the reservoir, with a consequent bad taste in the distributed water. The phosphate feed was then discarded and a further study was made on what to do, using soda ash in the meanwhile. Investigation disclosed that the metaphosphate had been converted to orthaphosphate by the air in the reservoir, thus providing the very fertilizer that the green algae required for further fast growth. After consultation, it was decided to add chlorine ahead of the aerator, and possibly after it if required. Accordingly, 2.3 ppm of chlorine were fed directly ahead of the aerator and all of the deposits in the aerator have disappeared. No discoloration is seen on the zeolite or on the side concrete walls of the gravity zeolite softener. However, when soda ash is added to get the pH value to 7.9, there is a sweet taste in the water which is found in lime treated water supplies. It has been suggested that lime be used instead of soda ash for this purpose. Chas. P. Hoover suggested that the aerator be abandoned entirely to prevent adding oxygen to the water supply, and suggests that soda ash be used to adjust the pH to about 8.0 or 8.1, and finally adding about ¼ ppm sodium hexametaphosphate to prevent deposition of $CaCO_3$ due to the higher pH.

A new material has suddenly received wide notice in the form of silica gel (50, 51, 52) which is used to protect overseas metal shipments so that corrosion will not occur or will at least be retarded to a great extent. This form of gel has been used to envelop airplane engine motors, machine guns, etc.

Moisture corrosion of metal parts will not take place if the relative humidity of the surrounding air is less than 30 per cent. Consequently, if a very dry air can be assured, machined parts such as aircraft engines, instruments, rifles, generators, starters, communication equipment, tanks and automotive parts, etc. may be preserved indefinitely without resorting to heavy grease coatings or protective paints which must ultimately be removed. This greatly simplifies the preparation of such material for storage or shipment, and is of tremendous advantage in preparing the material for use at its destination. It becomes unnecessary to transport great quantities of degreasing solvents and chemicals, and the laborious operation of degreasing itself is eliminated.

Silica gel, properly made and prepared, has the property of absorbing moisture from the air, even at low humidities. Permeable cloth bags, containing from one ounce to one pound of silica gel are placed in the shipping container with the equipment to be protected, and the entire container is sealed against external moisture. The silica gel insures a dry atmosphere in the package since it has a capacity for absorbing considerable more moisture than the original space contains, and will correct unavoidable leakage in the outer seal.

Aircraft engines are further protected by means of perforated plastic cartridges, full of the gel, which are screwed in place of the spark plugs and crank case plugs during shipment and storage.

Some silica gel is colored with cobalt salts to give a visual indication of its condition. This type of gel is blue at maximum efficiency and fades to a light pink as its moisture absorbing capacity is used up. When the gel shows the pink or red color, it can be heated to drive off the surplus moisture and used over and over again. Silica gel weighs around 12 pounds per cu ft and will absorb about 90 per cent of its weight in moisture before it has to be regenerated.

Silica gel gives promise of extensive use, in air conditioning, as a catalyst in oil refining and synthetic rubber production, and in the making of medicinal agents both external and internal. Its absorptive capacity dries and prevents the spread of skin ailments when used as a talc. Internal intestinal poisons seem also to be effectively removed.

The various items which are today being protected from excessive moisture by using silica gel are indeed too numerous to mention; however, the general classes of products which must be protected for overseas shipment have been specified as follows:

1. Structural parts.
2. Major items, machine assemblies or sub-assemblies.
3. Tools and machine parts.
4. Metal rods and sheets.
5. Hardware and fittings.
6. Wire and cable.
7. Furniture — office and field.
8. Office machinery.
9. Kitchen and sanitary equipment.
10. Instruments, radio equipment.

To serve as a guide in determining the moisture conditions within a package, moisture indicator cards have been prepared which visually show the approximate relative humidity within. These indicator cards contain an indicating type silica gel which changes color from a dark blue to a pinkish white on the absorption of moisture. The four principal color stages between completely activated gel and that completely exhausted are printed on the card along with the approximate relative humidity for each color stage. Packages, etc. are designed with windows or transparent coverings so that the indicator card can be readily observed.

Several very excellent references are given in the attached bibliography covering symposiums on various corrosion problems which will not be discussed in this paper. They contain a great deal of valuable information on protecting metals against corrosion with the use of alloys, the use of metallic coatings, on pretreatment of

metals, and the use of organic coatings. The papers give data on outdoor weathering conditions on bare and metal coated specimens, influence of rainfall and smoke on corrosion of iron and steel, interpretation of results of tests covering atmospheric corrosion of iron and steel, galvanic corrosion by contact of dissimilar metals, and correlation between lab and service tests in very full detail (53, 54, 55).

A very interesting description of corrosion, based on the chemistry involved, and its effects on well screens is given in a bulletin entitled "Chemistry of Water" (56).

A book entitled "Boiler Feed and Boiler Water Softening" (57) by Blanning and Rich has much useful information and gives much data on corrosion and corrosion test methods, with the theories and methods of handling problems from a chemical standpoint.

National Aluminate Corporation Bulletin No. 30 (58) gives much valuable information on boiler feed water treatment in question and answer form as well as data covering corrosion and corrosion control.

"Handbook of Feedwater Treatment" (59) issued by Power, December 1941, is probably one the best issued to date, especially on the subject of corrosion protection in boilers, economizers, piping, etc. It has a very satisfactory method of stating chemical equations by means of a building block system which is easily understood.

The Institute of Paper Chemistry, Appleton, Wisconsin, compiled a series of bibliographic references on water and allied subjects pertaining to its use in the paper industry, many of which are applicable to water in other industries. There are a total of approximately 600 papers listed (60).

Two very interesting compilations were made for the Short Water Course at Purdue University in 1939 (62). One is on corrosion by C. D. Adams, who states that well over 3000 papers on corrosion have been published from the dates 1926 to 1935 inclusive. He covers theories on causes of corrosion, fundamentals of corrosion, factors influencing corrosion reactions, and factors promoting localized corrosion (pitting). The other compilation deals with the prevention of red water and of underground corrosion, and is taken mostly from Speller and Langelier. It gives information on prevention of corrosion under water by means of artificial coatings such as paints, metallic coatings, bituminous coatings, and cement linings.

Most people are familiar with the technique and use of the previously mentioned Langelier corrosion index system of reporting and controlling corrosion difficulties, which has been adopted in many plants and found very useful. Several interesting additions have been made to the original data and charts have been developed for quick interpretations of test results. In a great many states, the state departments of health report corrosion indexes.

Another interesting device is the Enslow continuous stability indicator, which continuously indicates stability by means of the so-called marble test which uses two tubes filled with pulverized granular $CaCO_3$ and connected in series. Water running continuously through these units will either dissolve $CaCO_3$ or deposit such of it as is not in a stable condition. If the water is aggressive, the degree of corrosivity will be revealed by the titratable alkalinity ($CaCO_3$) pick up and by pH value increase during its passage through the tubes. If the water is a lime-treated water, it may be unstable and deposit $CaCO_3$, the latter being revealed by a loss of titratable alkalinity and pH decrease.

Another interesting addition to the field of corrective measures for corrosion is the use of various forms of unstable mineral such as half-burned dolomitic lime. The water is neutralized and stabilized to a certain point by passing it through a mineral bed of this type. The acid, if present, is absorbed and the pH raised to a point somewhere above neutral 7.0 to 7.5. It has been reported that, in the use of some of these minerals, supersonic waves sometimes tend to reduce the carbonate hardness of water passed through it.

In a 600 psi boiler operation, the oxygen was removed from the feed water to a concentration of less than 0.005 cc per litre by a two-stage deaerator. In the first heater stage, 95 per cent of the oxygen and most of the free CO_2 are removed. In the second stage, the water is boiled and scrubbed with high velocity steam to give complete deaeration. The alkalinity is reduced by feeding sulphuric acid to the water ahead of the deaerator. Sodium sulphate is added to the deaerated water and this prevents the possibility of having any uncombined oxygen in the water within the boiler.

Steam contamination with sewage ammonia is causing a lot of trouble. It can be reduced by mechanical apparatus similar to the present deaerating equipment but differing greatly in dimensions and arrangements of parts. In one installation, ammonia is being reduced from 5 ppm to 0.01 ppm, the deammoniator being located ahead of the main station evaporator. It is suggested that a most economical arrangement would be to eliminate copper and copper alloys from equipment coming in contact with ammonia laden water.

A very important and interesting paper "Effects of Deaeration on pH Value," by J. D. Yoder, and another on "The Removal of Dissolved Gases from Boiler Feed Water" by A. E. Kittredge were read recently and have now been published. Both have valuable ideas and suggestions.

Another form of gas eliminator, a degasifier, has come into use for the liberation of CO_2 formed in the acid cycle of the hydrogen zeolite regeneration. It provides for rapid and efficient elimination of troublesome gases. The best degasifiers are of the slat tray type of construction which provides large contact surfaces with a counterflow of blown air to help the time element. They may be installed outdoors or indoors with no loss of water due to windage or drafts. This type of degasifier can also be used for the removal of malodorous and corrosive gases, and will prevent return line corrosion precipitation of iron and manganese.

In the articles by Yoder and Kittredge, a great deal of information on the theory of design has been given on the recent improvements in feed water heaters and accessories. Increased operating pressure in boilers means higher temperatures in feed water heaters, feed water lines, and boiler circulating setups. At the higher pressures, control of corrosion by pH is no longer a satisfactory solution, and the heater must be redesigned as a device for precise control of the mechanical oxygen extraction process. Most of the new designs call for two or more stages of steam contact of both exhaust and live steam, as well as supplementary feeds of chemicals, and new arrangements of trays, vent condensers and control instruments.

Major Rolf Eliassen describes in a recent article (100) "Corrosion Control in Potable Water Systems," the effect of temperature; dissolved oxygen removal, protective coatings, sodium silicate films, polyphosphates as inhibitors, combination treatments, proportional feeding and test loops. Reports are based on actual work conducted at a number of U. S. Army camps.

A magazine "Corrosion and Material Protection" has just appeared that seems to fill a long felt want in the field of corrosion; and the first issue April 1945, contains many interesting articles. Also for those in search of specific articles or references on corrosion subjects, Mr. V. V. Kendall, corrosion engineer, The National Tube Company of Pittsburgh, Pennsylvania has a file containing over 10,000 items covering in detail the subject of corrosion.

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by N. W. Richardson

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▲OVER past decades, open hearth, billet heating furnaces, heat treating furnaces, etc., have been improving their practice, but not until the past few years has much thought been given to new and improved soaking pit practice. With more rigid specifications for quality steels coming into the picture every day, many pit installations have been modernized in the nation's steel plants and many others are contemplating the installation of modern pit designs.

In a large portion of the country's steel plants the old regenerative type pit is still used. In this type of pit, difficulties often arise in that the operators are unable to obtain uniform heating. To combat this trouble it has been necessary, in many cases, to turn the ingots around during the heating cycle, and in some cases it is necessary to consistently charge hot top ingots with the tops down to prevent slagging. This, of course, requires many additional man hours and a much longer heating time, and results in curtailed production. Yield has also been considerably reduced on mills which utilize this type of heating, due to edging cracks, burnt ingots, etc.

The typical regenerative fired soaking pit with pull-back covers, air regenerators, and gas recuperators, is capable of operating on any mixture of gaseous fuels, but no matter what fuel is used, the biggest part of the operation of the pits is left to the skill of the heater, and, considering the crudeness of the equipment and the almost complete lack of control instruments, one must admit that on the whole the heaters have been doing a very creditable job.

On the old type of regenerative pit, because of its uneven heating and washed ingots, cinder collects in the pit bottom, necessitating frequent bottom making. Cold butts or cold tops are prevalent, tending to cause cracks which in many cases must be chipped or scarfed out of the ingot at great expense before the steel is ready for further processing.

Heavy scale losses and high chipping costs, plus poor fuel economy and, in most cases, more time consumed in bottom making, are factors prevalent in a large number of steel mills today.

Thanks to the modern soaking pit, this picture is rapidly being changed and this has been possible largely through the advent of accurate, sensitive and reliable automatic control of combustion, pressure and temperature. Radical changes in soaking pit design have also contributed their quota and made the application of control more successful.

Soaking pit practice is no longer left to the judgment of the heater. Calibrated instruments tell him exactly what is going on within the pit during the entire course of the heating cycle. These instruments tell him the temperature that is being maintained, the exact ratio of fuel to air, the pressure in the pit itself, the atmosphere surrounding the ingots and the rate at which fuel is being burned. The most important of all these conditions is the fact that having decided what type of heating is required for the particular class of steel to be heated, the operator merely sets his instruments to the desired characteristics and can go away confident that these

conditions will not change in his absence. The result is that day after day these modern soaking pits will reproduce correctly heated ingots of a uniform rolling temperature, free from washing and with controlled scale conditions.

All of the above features, incorporated in the modern soaking pit, produce uniformly heated ingots and result in blooms or slabs of higher quality, which is noticeable all the way through the mills to the finished product. Roll breakages with consequent mill delays have been reduced as well as power consumption on the blooming mills. Easier draught regulation has also resulted.

Another important advantage of the new types of pits with complete automatic control is the marked reduction in fuel cost per ton of ingots heated. Although fuel economy is, of course, secondary as compared to the great improvement in heating, it is, nevertheless, of real importance in production cost.

Owing to the crudeness of the design of the cover on the old style pits, in order to maintain pressure, flames blew out around the cover, burning out the supporting framework and consequently increasing the maintenance costs. In addition, they were and still are fitted with a cover lifting mechanism which jolts and jars the covers to such an extent that brick repairs are a frequent occurrence.

Much difficulty is also encountered in maintaining pit bottoms due to slagging of the ingots.

Features common to all of the new pits are: (1) a well designed cover-operating mechanism which gently but swiftly raises and lowers the covers, thus reducing excessive repairs on the cover brickwork, and (2) sand seals and proper pressure control that eliminates flame blowing out around the base of the covers.

These new type covers are gently handled by their different types of cover lifting mechanisms. On some type of pits individual cover lifting mechanisms are utilized for each cover while in other types, pit cover cranes handle several pit covers. All of the covers on the new types of pits are lifted vertically out of the sand seals, and then traversed laterally to the desired position. Electrical interlocking prevents any traversing movement until the dome or cover is lifted clear of the sand seal, and also prevents the cover from lowering over the pit until it is in proper position over the sand seal. One can readily see that maintenance on covers of this type is reduced to a fraction of that of the old type pits. In addition, accurate pressure control is now completely successful and such control is indispensable if combustion control is to be accurate.

All of the new design pits are steel encased and provided with adequate insulation, thus eliminating air infiltration and cutting radiation losses to a minimum.

Four different designs of pits which are more or less revolutionizing soaking pit practice are:

1. The one-way fired recuperative pit which was probably the first to depart from the conventional reversing or regenerative type pit used for the past twenty years. This one-way fired recuperative pit was the first pit to successfully use a recuperator for preheating the air for combustion. It was novel in its method and application of fuel with respect to the loading arrangement of the steel to be heated.

   The pit, rectangular in shape, is fired from a port or ports located in one end wall at a level above the tops of the ingots. The combustion space is obtained by the fairly large clearance between the tops of the ingots and the cover.

   The waste gases follow a horseshoe curve, going to the far end of the pit, thence downwards and back past the butts of the ingots and out at a port in the end wall below the burner port. A collector flue across the back of the pit leads the gases through a tile recuperator and thence to the stack.

2. The bottom-fired recuperative pit is one of the newer types, being rectangular in shape, with the shape approaching the square more than the oblong hole normally used in the regenerative and one-way fired pit.

   It is fired through a port in the center of the pit bottom. The ingots are placed around the pit walls forming the initial combustion chamber, and the flame passes upward, mushrooms off the pit covers and passes downward around the back of the ingots to a number of exit ports in the bottom side walls of the pit. From the exit ports the waste gases pass through air recuperators located at each side of the pit and thence to the stack.

3. The end-fired recuperative type pit is also rectangular in shape, being fired from the center of each end wall, the burners being placed vertically on the center line of the end walls. The ingots are placed along the side walls of the pit and the gases circulate around the center of the pit between the ingots and are vented through outlets in the bottom of the pit walls where they pass over recuperators, and thence to the stack by means of connector flues.

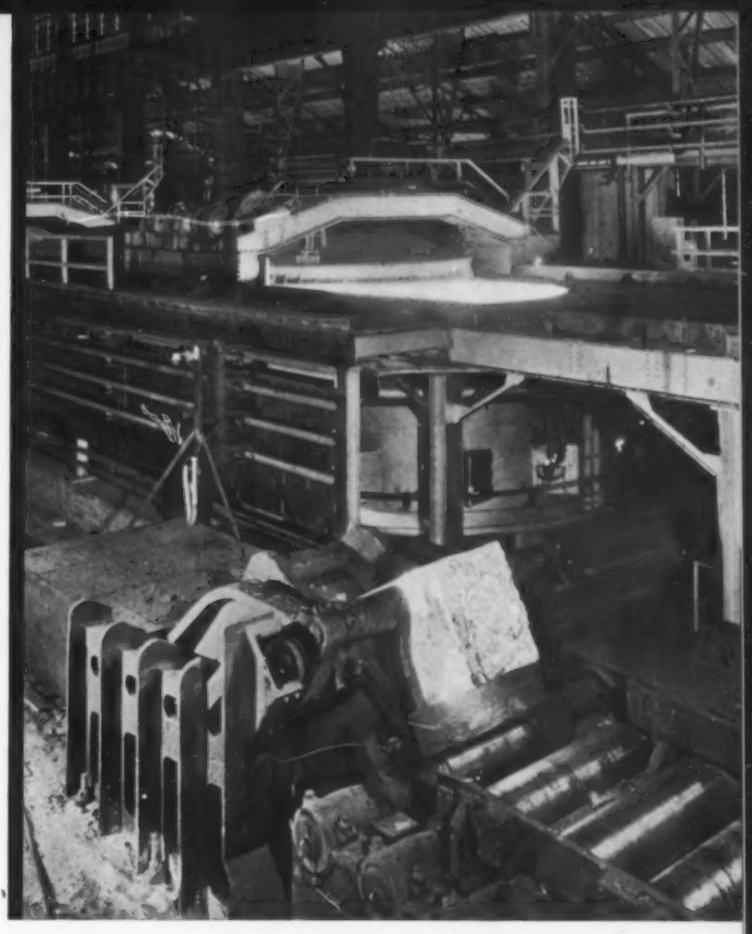


Figure 1 — View of circular pit with cover moved into position for charging and drawing. Ingot car is discharging an ingot on the mill table in foreground.

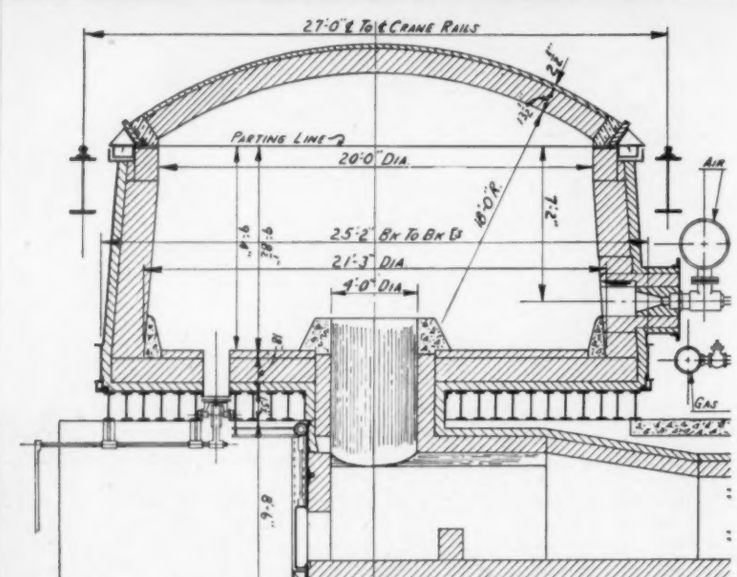


Figure 2 — Sketch of circular pit showing details of construction. Burners are spaced evenly around the pit near the bottom.

4. The last of the different modern soaking pit designs to be discussed is the circular pit. It consists of a circular steel encased furnace, fired tangentially around the bottom of the pit by means of a number of small burners firing into the circular combustion chamber which is formed by the sloping walls behind the ingots. The gases circulate around the combustion chamber, work their way through the ingots and to the top of the pit and are then pulled downward to the flue exit in the center of the pit bottom and thence to a recuperator or direct to the stack dependent upon the particular installation.

The idea for the design of the first circular pit was taken from the cylindrical type wire annealing furnace with the thought that the same principle of firing could be used for heating ingots, although many additional factors had to be considered, since the ingot heating furnace has to operate at a much higher temperature.

The furnace was designed to provide a uniformly heated product at low heating, operating and maintenance costs. With this in mind, the circular soaking pit was built with a design which is free from all unnecessary and costly auxiliary apparatus.

In the past, several different sizes of circular pits have been constructed ranging in size from 11 feet in diameter up to and including 20 feet. The most practical of the various sizes are the smaller pits ranging from 11 feet to 16 feet. When the plant has large open hearth capacities, say 100 to 150 ton furnaces, it is better to split the heats, with perhaps one-half of a heat to a pit, dependent of course, upon the size of ingots charged. For the large slabbing ingot, the larger pit is better due to loading conditions. Where smaller ingots are being used, ranging from 16 inches square up to 32 inches square or even 42 inches square, the smaller pits have the advantage.

On the smaller pits which are placed side by side, inter-connecting flues can be applied to make construction more simple. The smaller pits, constructed in batteries of four pits to one common stack, thus make possible a more economical application of recuperators. The application of recuperators is dependent upon many factors, including cost of fuel, availability of fuel and Btu content of gas. The saving that can be made from recuperation is approximately 20 per cent of fuel on any type of pit, dependent of course, upon temperature of steel when charged.

Fuel can be either natural gas, coke oven gas, a mixture of blast furnace and coke oven gas, producer gas or oil. Combination type burners can also be installed to operate either on gas or oil. The circular pit has been operated on gas with a calorific value of 180 Btu per cu ft.

Air for combustion is supplied to the burners on the non-recuperative circular pits by means of blowers operating at 12 to 20 oz pressure, dependent upon the particular application. Location of the burners on the circular pit on one horizontal plane makes them conveniently accessible for inspection and adjustment.

The angle at which the burners are set into the furnace is very important. The fact that the active heating gases are always moving in a spiral path makes a high rate of circulation possible with relatively low burner velocities. There are no stagnant pockets of gases. It has been estimated that the whirling action of the gases within the circular pit move at a velocity of about 50 fps, and that the gases make at least two or more complete revolutions in the furnace before entering the waste gas outlet. Thus the gases in the circular pit travel approximately 100 ft or more before leaving the furnace, which is from three to ten times as far as in any other type of ingot heating equipment.

Burner ports are made long so that practically complete combustion takes place within them. In this way the fuel is burned at maximum efficiency and at higher temperatures without in any way impinging on or injuring the ingots being heated. Gases which already have come in contact with the ingot and have given up part of their heat form a blanket or cushion between the hot gases emitting from the burner, and thus temper the temperature of the two gases. It is this temperature of mixed gases which is used to control the flow of fuel to the burners.

The one control pyrometer is located just above one of the burners and measures the temperature of the combustion products which are coming in contact with the ingots. This form of temperature measurement is direct and need not be corrected by allowance for drops or for averages.

It can readily be realized that a considerable amount of uniformity of heating is due to convection as well as radiation, because of the high velocity of the gases surrounding the ingots being heated.

The circular form in which the furnace is built is a design which has many advantages among which are the maximum furnace area for a given wall area. The circular furnace uses the full centered arch construction throughout. The furnace itself is in this form, and the burner ports and the dome are also in this form. No expansion joints are used in the brickwork of the circular pit; however, the outward expansion of the circular

brickwork is taken up several places around the outside of the steel furnace shell.

There are various grades of brick used in the construction of the circular pit, dependent upon the location and service required during operations. The furnace side walls consist of a total thickness 18½ in. at the top made up of 13½ in. of high grade fire brick backed up with 5 in. of graduated insulating brick. The pit sloping wall and burner consist of 13½ in. of high grade firebrick backed up with 10 in. of graduated insulating brick. Burner ports are lined with double burned brick and chrome brick; the center flue also is lined with chrome; the furnace dome is constructed of 13½ in. of high grade firebrick with a 2½ in. course of insulation laid on top.

The cover rim is made of heavy structural sections protected by castings. The furnace dome rests on the top of the pit and the sand seal trough. This trough is on the outside of the furnace proper, and is cooled by exposure to the air. There have been no difficulties with the sand seal, such as may occur with some seals placed on a common wall between holes.

In regard to cinder removal, the uniform heating obtained plus the thinness of scale result in no large amount of cinder formation, although this varies with operations at various installations. So far, cinder has presented no problems whatsoever. Cinder can easily be removed. Due to the method of firing the circular pit, hot tops will not run during normal operations, and it is not necessary to charge hot top steel with the tops down to prevent slagging.

Cinder is removed from this pit either through cleanout openings in the pit bottom or through the center waste gas flue which has a cleanout door at the base.

The pit covers are lifted by means of a motor-operated cover crane which serves any number of pits. With this type of cover mechanism, it is possible to move the covers longitudinally in the pit building; therefore, saving floor space and making the installation entirely independent of building column spacing. During normal operations, the cover is moved by the crane a little over half way in either direction of the furnace to enable the pit crane operator to charge or draw ingots without opening the complete pit.

Cover cranes can be constructed to raise one cover over the other and travel the full length of the building if desired, thus eliminating the necessity of using soaking pit cranes to handle the covers when repairs are necessary. The cover cranes are provided with an operating platform or control house. The cranes also can be operated by remote control if this is desired from a pulpit on the soaking pit crane.

During normal operations, the bridge of the crane is moved into position over the top of the desired furnace and, while in this position, limit switches operate which permit the crane operation to raise the cover the necessary distance to clear the sand seal. When the cover is raised to its full height, the limit switches are automatically reset so that it is possible to move the cover crane and the cover to either side of the pit so that the pit crane operator can charge or draw his ingots. It is impossible when the crane is not in the proper position over the pit, for the operator to lower the cover on the pit floor.

The number of cover cranes is dependent entirely upon the number of pit cranes, one cover crane being usual for each pit crane. On large installations, it is better, however, to have one extra cover crane to remove covers for making bottom.

The controls for the circular pit are primarily the same as those used on any heat treating furnace. They are temperature, pressure and combustion controls. Temperature control for the pit consists of a recording controlling radiation pyrometer arranged for proportioning control and reversible time rate device. This type of control includes butterfly type motor operation, proportioning air valve, plus automatic droop correction.

To set the controller, the operator turns a knob inside the case door moving the red pointer along the indicating scale to the temperature desired. He then sets the

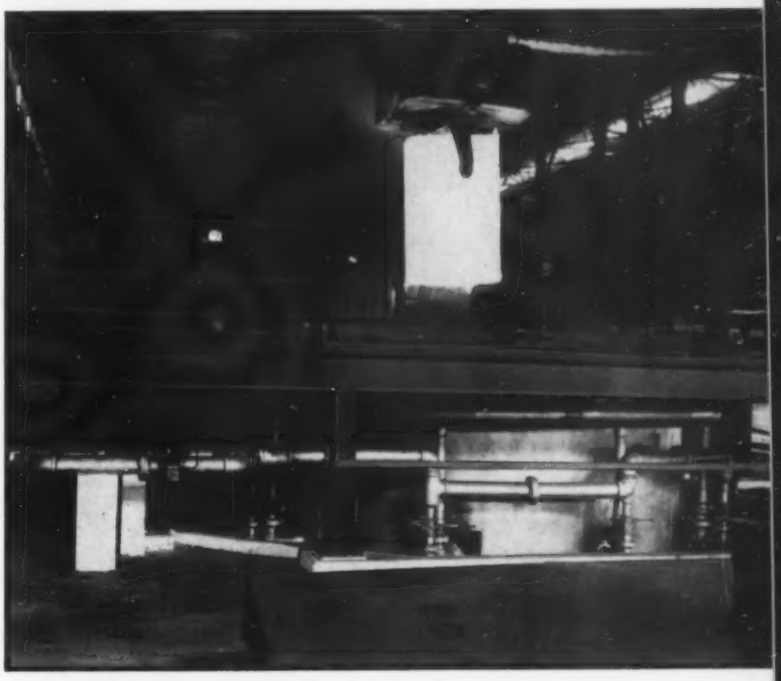


Figure 3 — Large slabbing ingot being withdrawn from circular pit. This view indicates the accessibility of the burners.

▲

Figure 4 — Typical control panel for two circular soaking pits. Complete automatic control of temperature, furnace pressure and gas-air ratio is provided.

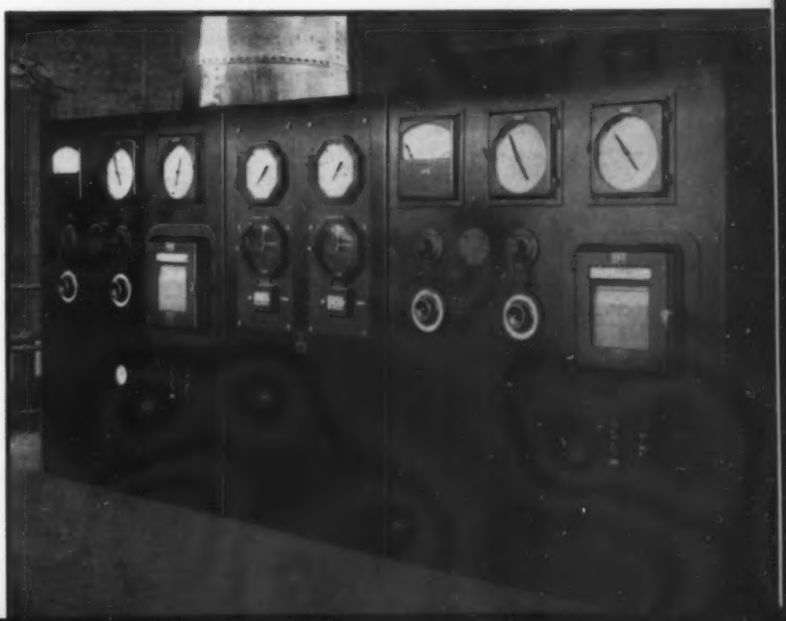


Figure 5 — Battery of nine circular soaking pits, served by two cover cranes and an ingot car running along the length of the row.

time rate device at whatever number of degrees per hour he wishes the temperature to rise. He will then set the timer to hold the soaking period for any predetermined length of time desired.

The time-rate device actually keeps raising the temperature setting at a definite rate. It operates through a synchronous speed motor and an interrupter. The above pertains to heating cold steel only; on hot steel it is not necessary to use the time rate control. The pressure within the furnace is held constant by means of suitable pressure control equipment. The pressure in the furnace itself actuates a stack damper which holds the desired pressure as set by the heater.

Temperature from top to bottom in the circular pit will not vary over plus or minus 10 degrees F in normal heating practice.

The pressure control equipment consists mainly of a controller, oil pump and tank, impulse lines and a hydraulic cylinder. A short pipe is inserted in the furnace sidewall called the pressure tap. Variations of furnace pressure are transmitted to the diaphragm in the pressure controller, and this diaphragm will cause the oil pressure in the damper operating cylinder to change, thus raising or lowering the damper.

When burning gas, the rate of gas flow to the burners is measured by an orifice in the gas line, the differential being imposed on the outer diaphragm of a double diaphragm oil operated regulator. Air flow to the burners is similarly measured, with the differential being measured across an orifice in the forced draft blower outlet line. This differential is imposed on the inner or controlling diaphragm of the same regulator. The ratio to be maintained between gas and air is determined by the relative position of the movable fulcrum incorporated in the ratio regulator.

Any alterations of the ratio of gas to air from the standard setting will cause the ratio regulator to deliver oil pressure impulses to either end of a power cylinder. By means of linkage from the piston rod of the cylinder, a control damper in the discharge line of the blower is actuated, and thus the quantity of air supplied to the burners will be maintained constantly in the desired ratio of air to gas. The fulcrum in the ratio regulator is adjustable so that any desired atmosphere may be obtained within the furnace.

The number of ingots that may be charged in the circular pit depends upon their size and is limited by the ability of the pit crane tongs to get between the ingots. Small ingots may be leaned against the pit wall when charged, and loaded in two rows or more and still get uniformity of heating. The large ingots may be stood up on the pit bottom.

Fuel consumption per ton of ingots is dependent upon many factors, including track time for ingots from the open hearth, temperature of ingots when charged, heating rate, soaking or holding period, etc. The circular pit will not require any more fuel per ton of steel heated than any other pit, provided they are both figured with or without recuperation. For example, take a heat of eleven 23½ x 25 in. ingots at 5.25 tons each in one 13-ft diameter circular furnace with a 2 hour and 45 minute track time. The fuel consumption based on a maximum rise of 800 degrees from 1550 to 2350 F will be approximately 800,000 Btu per ton of steel heated. With recuperation whereby a maximum fuel savings of 20 per cent can be obtained, the differential would be 160,000 Btu per ton and gas would have to be at least 20 cents or more per million Btu in order to pay for the installation cost of recuperators over a period of ten years or better.

Recuperation is essential on some pits with a small number of burners in order to obtain proper flame characteristics, to prevent burning up the pit brickwork, or to enable the burners to burn the volume of gas required for heating. This is not true, however, on the circular pit with its multiple burner design. The only reason for the addition of recuperators to the circular pit is for operation on low Btu gas where additional flame temperature is required for heating. The amount of fuel savings accomplished by recuperation on circular pits is not sufficient to pay for the initial installation cost for periods of ten years or more dependent upon fuel cost.

In summarizing the circular soaking pit, there are the following ten major factors:

1. Fuel is supplied to the furnace at a number of points, with the result that no section of the pit is at any time receiving a large mass of flame. Consequently no individual ingots are being over-heated and temperature within the pit is uniform.
2. Circular construction gives a strong design, which reduces maintenance cost to less than 1½ cents per ton over periods as long as five years.
3. With uniformity of heating, temperature control becomes accurate and it is possible to obtain ingots from the pit varying not more than 20 degrees F from top to bottom. Pit temperature is controlled to within plus or minus 10 degrees.
4. Ingots do not have to be turned to get uniform heating, nor need ingots be charged into the pit with the hot tops down to prevent slagging.
5. Complete automatic control is available reducing labor and operating cost.
6. Faster rates of heating can be obtained on alloy and high carbon steels due to the tangential firing of the burners.
7. Floor space requirements are low in relation to ingot heating capacity.
8. No recuperators are required to obtain high flame temperatures.
9. Mill yield is improved because of fewer rejections arising from faulty heating.
10. Scale loss is low because of uniform heating.

Special Announcement

The Kelly award, founded by the Association of Iron and Steel Engineers to perpetuate the memory of its first managing director, John F. Kelly, has been amended to include second and third places, as well as monetary prizes. The award now carries annual cash prizes of $300, $200 and $100, respectively, for the three papers selected as most valuable to the industry from those published in the Iron and Steel Engineer during each calendar year.

This annual competition is open to all employees of the iron and steel industry, whether they are members of the Association or not.

The competition is open to independently submitted papers as well as to papers which have been requested and presented at Association meetings.

Judgment of winners is on the basis of the value of the paper to the advancement of technical and engineering phases of the production and processing of iron and steel.

Papers may deal with design, construction, operation, application or maintenance in iron and steel plants.

Judging is performed by the editorial and executive committees of the Association.

All papers submitted become the property of the Association of Iron and Steel Engineers, although those not published in the Iron and Steel Engineer will be returned to the author. Send your entry to the

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 EMPIRE BLDG. PITTSBURGH 22, PENNSYLVANIA

Induction Heating

. . . . induction heating has vast possibilities because of its properties of applying heat in the local area where it is desired, and because of its rapid rate of heating . . . .

by N. R. Stansel

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ INDUCTION heating is the use of the principle of electromagnetic induction for heating service. The mass to be heated or the charge, which must be of conductive material, is exposed to an alternating (or varying) magnetic flux. The currents thus induced in the charge flow wholly within its mass. Such currents are termed eddy currents; hence the term eddy-current heating sometimes applies to this use of the i^2r effect.

Assemblies — Various arrangements of parts are used to obtain the exposure of the charge to the magnetic flux. In all cases the assembly is a form of transformer. A typical arrangement is illustrated by Figure 1. The coil around the charge forms the primary circuit. The path of the current in the charge is the secondary circuit. The directions of the alternating magnetic flux established by an alternating current in the coil are parallel, approximately, to its longitudinal axis and hence to the lateral surface of the charge.

The direction of the transformation of electric energy to heat in the charge is normal to the directions of the alternating magnetic flux. This directional feature, the one-way flow of energy, is a basic concept of induction heating.

Heat effects — A heat application refers to a more or less definite temperature. In come cases this specification is more rigid than in others. The properties of a material vary with its temperature. We are concerned primarily with the effects of heat on the electric and magnetic properties of metals and alloys.

Presented before A. I. S. E. Birmingham District Section Meeting, April 30, 1945.

Resistivity — The resistivities of metals in the solid state increase with rise of temperature. With a few exceptions, mainly zinc and cadmium, this is true also for metals in the molten state.

The graphs of Figure 2 show the resistivity-temperature relations of iron and carbon steel in the solid state. The resistivities of molten steels are within the range of 150 to 200 microhms centimeter cube; the value in each case depends on the analysis of the steel and its temperature.

The common low resistivity metals are aluminum and copper. The resistivity-temperature relations of these metals are shown in Figure 3.

Permeability — The magnetic property of an iron-carbon alloy depends on its composition, its crystal structure, magnetic history and on its temperature. The saturation values of the permeability of iron-carbon alloys are within the range of 16 to 24. The average value for carbon steel is around 20.

The magnetic property is but little affected by heat until the temperature of the alloy approaches the Curie point, a value around 760 C (1,400 F), depending on the carbon content. At that temperature the permeability becomes unity. The change is abrupt.

Certain steels referred to generally as austenitic steels, are nonmagnetic.

Hysteresis — The rate of heat development by hysteresis in a magnetic material decreases continuously with rise of temperature. This effect has a certain value in heating magnetic materials to comparatively low temperatures.

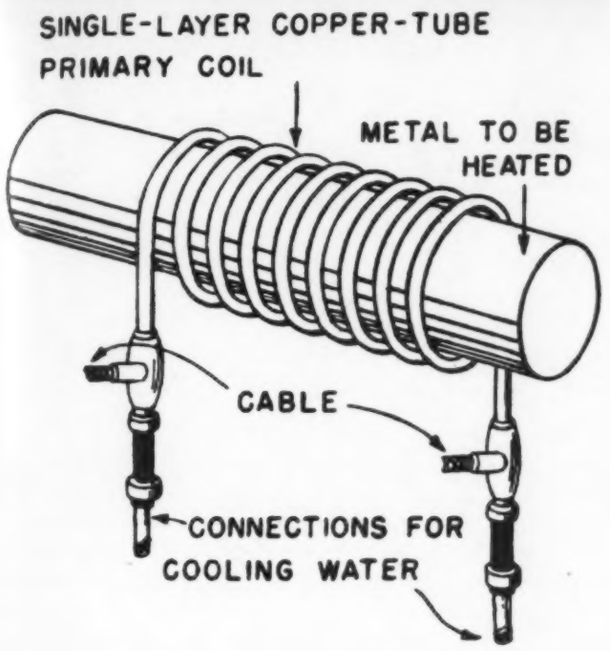


Figure 1 — Assembly for induction heating, less supports, with solid cylindrical charge.

Types of charges — The effect of heat on the magnetic property of magnetic materials makes it necessary to classify charges in induction heating practice as follows:

Type I — Charges of nonmagnetic material.
Type II — Charges of magnetic material. Maximum temperature below the Curie point.
Type III — Charges of magnetic material. Maximum temperature above the Curie point.

Heat content — The heat contents of metals up to and above the melting points are shown in Figures 4 and 5. The horizontal sections of the graphs indicate latent heat quantities.

Heat loss — With the exception of metal melting service, for which containers are required, there is no heat insulation of the charge. That is, the charge is heated in open-air or in a protective gas atmosphere. Hence, there is a continuous loss of heat from the surfaces of the charge, mainly by radiation, during the heat cycle. Also if the charge is part of a body, such as the end of a shaft, there is a loss of heat by conduction from the charge to the cold mass of the body.

The rate of loss of heat by radiation is determined by the temperature of the surface of the charge, the temperature of the surroundings and by the emissivity coefficient of the surface of the charge. Average values of the rate of heat loss by radiation from charges in open air are given in Figure 6. A protective gas atmosphere may reduce these values to some extent.

Cardinal relations — The factors which, for a given intensity of magnetic flux at the lateral surface of a charge, determine the rate of heat development in the charge are:

(a) The dimension of the charge that is normal to the directions of the alternating magnetic flux. This dimension is referred to herein as the base dimension of the charge.
(b) The electric and magnetic properties of the material of the charges.
(c) The frequency.

The relations of these factors are expressed by the equations which follow.

Reference dimension:

$$p = \frac{\sqrt{\rho}}{2\pi\sqrt{2}} \frac{\sqrt{10^9}}{\sqrt{\mu f}}$$

$$= \frac{3560\sqrt{\rho}}{\sqrt{\mu f}} \text{, centimeters} \qquad (1)$$

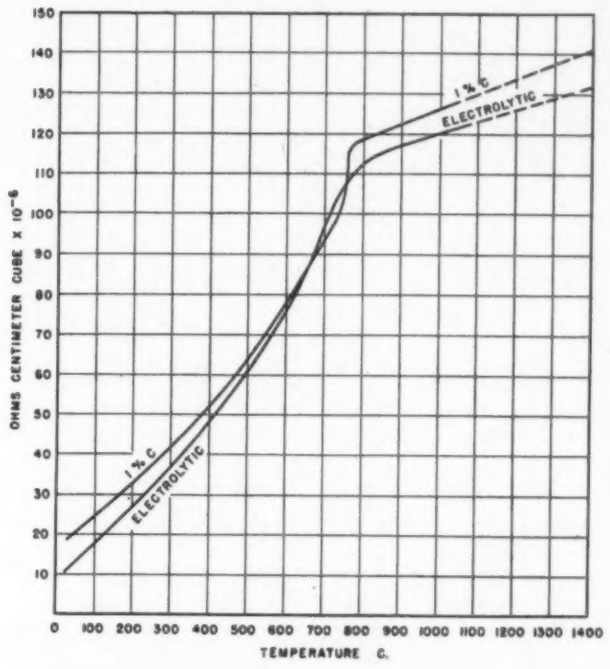
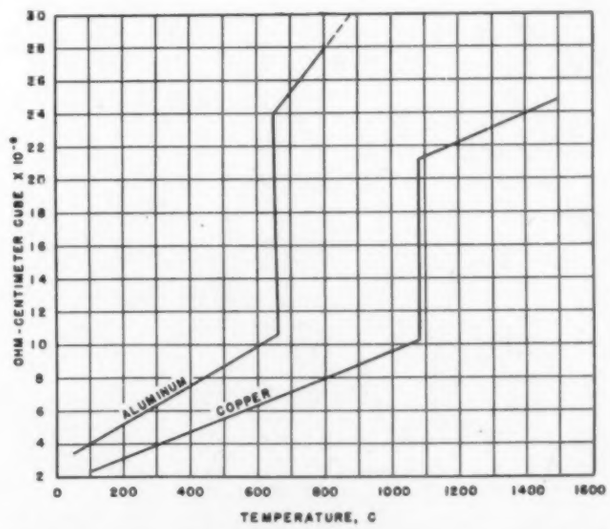


Figure 2 — Resistivity-temperature relations of iron and carbon steel in the solid state.

▲

Figure 3 — Resistivity-temperature relations of aluminum and copper.



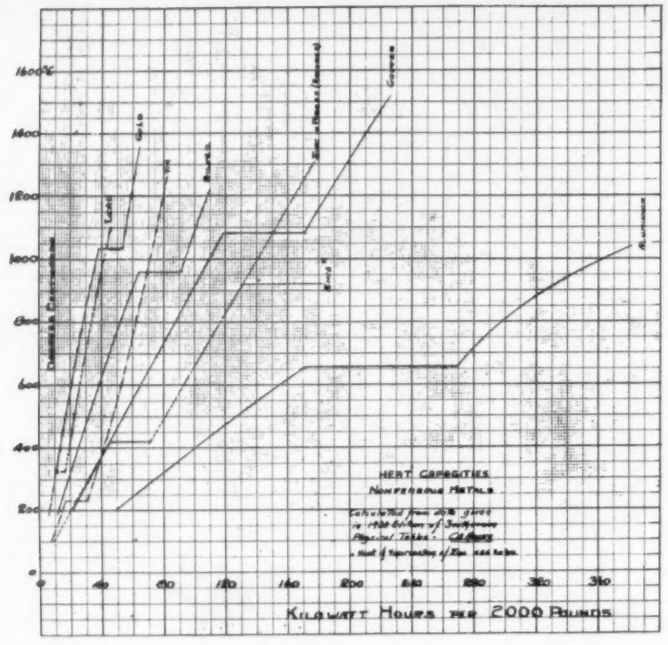


Figure 4 — Heat contents of various metals.

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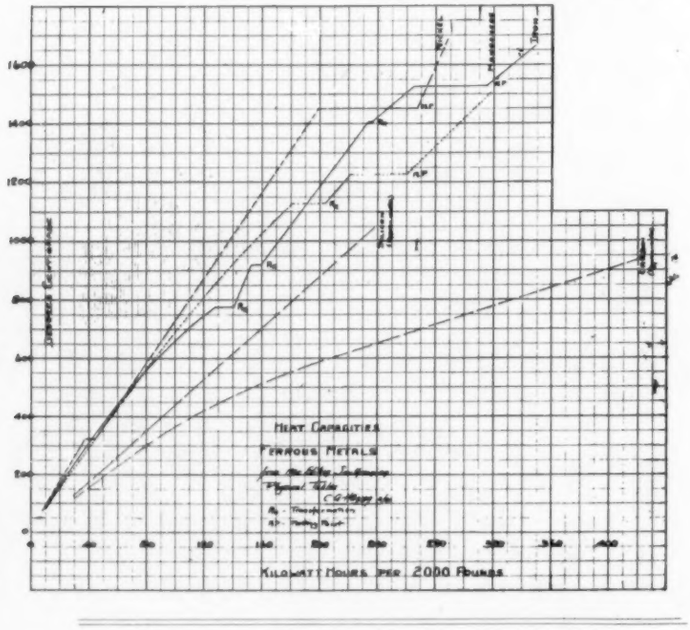
Figure 5 — Heat contents of metals not shown in Figure 4.



ρ = the resistivity of the material of the charge at the temperature specified for the heat application.

μ = the permeability of the material of the charge which corresponds to the value of resistivity noted above.

f = frequency, cycles per second.

The numerical value of the ratio of equation 1 is used as a dimension — hence the term reference dimension.

Index ratio — The index ratio is the ratio of the base dimension and the reference dimension multiplied, for other than solid cylindrical charges, by a constant, and is illustrated in Figure 7. Two examples, a solid cylindrical charge and a charge with a thin rectangular section, are given.

Solid cylindrical charges:

$$\Delta = \frac{a}{p} = \frac{a\sqrt{\mu f}}{3560\sqrt{\rho}}$$

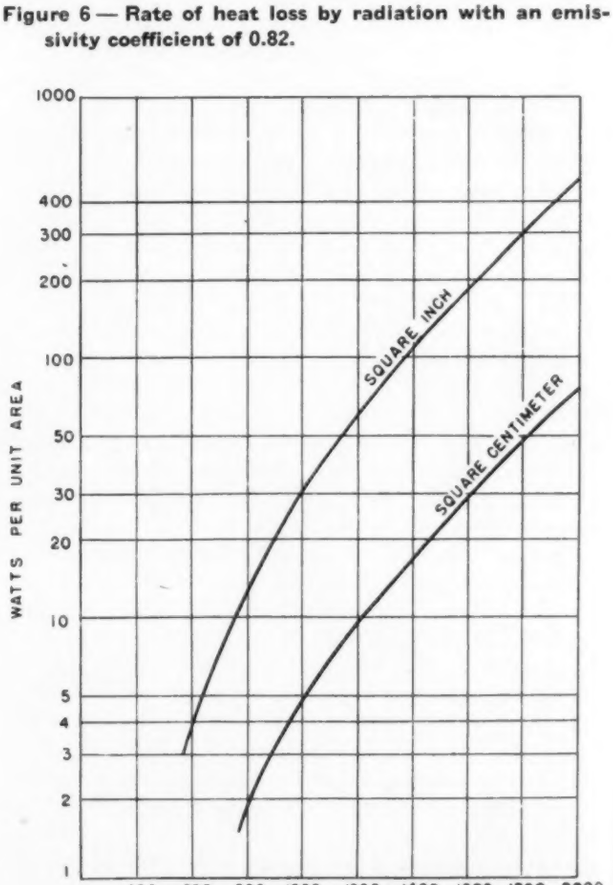
Charges with thin rectangular sections:

$$\nabla = \frac{\sqrt{2}\,c}{p} = \frac{\sqrt{2}\,c\sqrt{\mu f}}{3560\sqrt{p}} \qquad (3)$$

The generalization of these equations is the common usage of ratios in engineering analyses. The value of the index ratio is indicative of the technical and economic merits of a design for induction heating. Thus this ratio is the primary guide in applications of this method of heating.

Flux and current distribution — To return to the transformer relation of the introductory paragraphs, the currents induced in the charge will alter the strength of the magnetizing force. Hence, this force will have different value in the mass of the charge at different

Figure 6 — Rate of heat loss by radiation with an emissivity coefficient of 0.82.



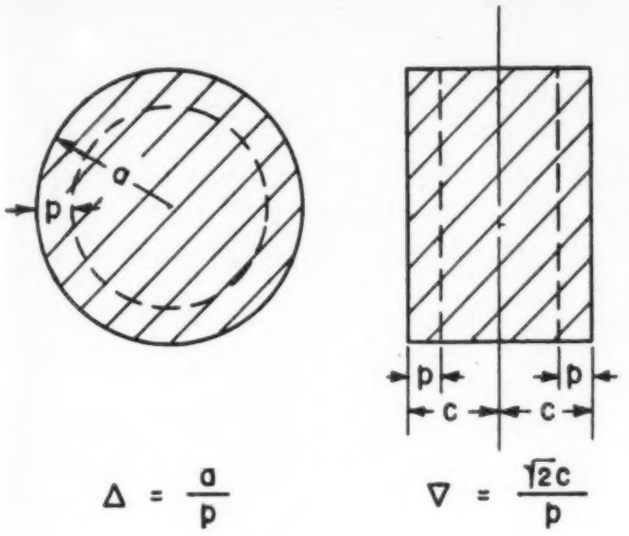


Figure 7 — Index ratio diagrams.

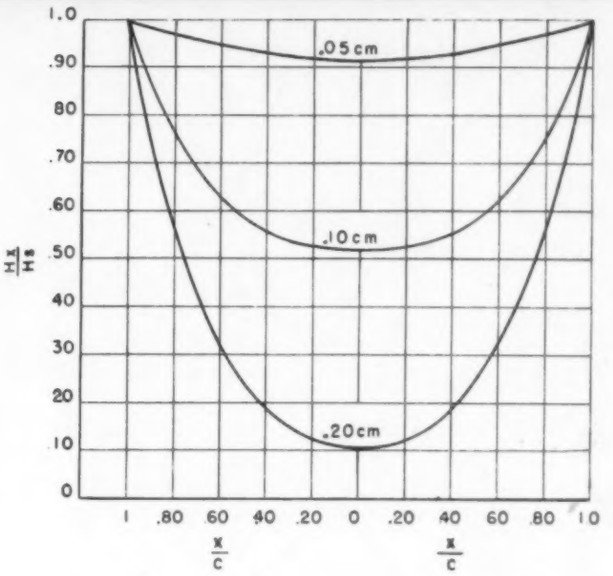


Figure 8 — Distributions of alternating magnetic flux in steel sheets.

distances from and normal to the surface of the charge that is exposed to the magnetic flux.

The consequent distribution of flux intensity in the charge is illustrated by Figure 8, a reproduction from a paper by Ewing[1]. The graphs of this illustration show the relative intensities of alternating magnetic flux across the sections of three thicknesses of steel sheets when the lengths of the sheets are parallel to the directions of the magnetic flux. The graphs do not show instantaneous values.

It is seen from Figure 8 that the intensities of the magnetic flux across the sheet section vary with the thickness of the sheet. The flux and the corresponding induced currents in the 0.20 centimeter sheet are confined largely to the surface zones. The degree of this concentration is less in the 0.10 centimeter sheet and the flux and current distributions in the 0.05 centimeter sheet are practically uniform.

The data of Table I are from Ewing's paper. The values of the eddy current loss (the term for the undesirable heat developed by eddy currents in metallic structures) are given in watts per pound and the values of the index ratios are added to Ewing's data.

TABLE I

Eddy Current Losses in Steel Sheets
Frequency — 100 cycles
Flux Density — 4,000 gausses
Resistivity — $10 \div 10^6$ ohm-centimeter cube
Permeability — 2,000

Thickness of sheet	Watts per pound	Index ratio
0.20 cm (0.074 in.)	3.35	5.6
0.15 cm (0.059 in.)	2.50	4.2
0.10 cm (0.0395 in.)	1.41	2.8
0.05 cm (0.0197 in.)	0.39	1.4
0.025 cm (0.010 in.)	0.097	0.70

A study of Figure 8 and Table I reveals that uniformity of flux distribution (a low value of the index ratio) is necessary to obtain a low rate of heat development by eddy currents. This is accomplished in the conventional transformer by the use of thin sheets (or laminations) for the core assembly.

On the other hand a non-uniform or near-surface concentration of magnetic flux — that is, a comparatively high value of the index ratio — is needed for heating service. The electric and magnetic properties of the material of the charge and its dimensions are given values. Thus frequency is the factor of selection to obtain the desired value of the index ratio.

Heat concentration — The shape of the charge is taken into account in analyses of induction heating problems. However, shape alone does not affect the principle involved.

The concentration of heat development toward the lateral surface of a solid cylindrical charge is illustrated by a graph of the squares of the current density values as shown in Figures 9 and 10. In each case the value at the radius $(a - \frac{p}{2})$ is taken to be 100 per cent.

The data for Figure 10 are the same as for Figure 9 with the exception that the frequency is four times that of Figure 9. Thus, these two illustrations show the effect of frequency on the concentration of heat development by currents induced in the charge.

Volume V_p — The concentration of heat development in the charge is expressed as the percentage of the total watts in the charge that is developed in the annular zone V_p shown in Figure 11. This zone is defined by the radial dimension p, the reference dimension. These percentages for values of the index ratio are shown in Figure 12. With frequencies which give index ratios above about 5 the percentage is practically constant, the value being 76 per cent.

The graph of Figure 13 shows values of the ratio of

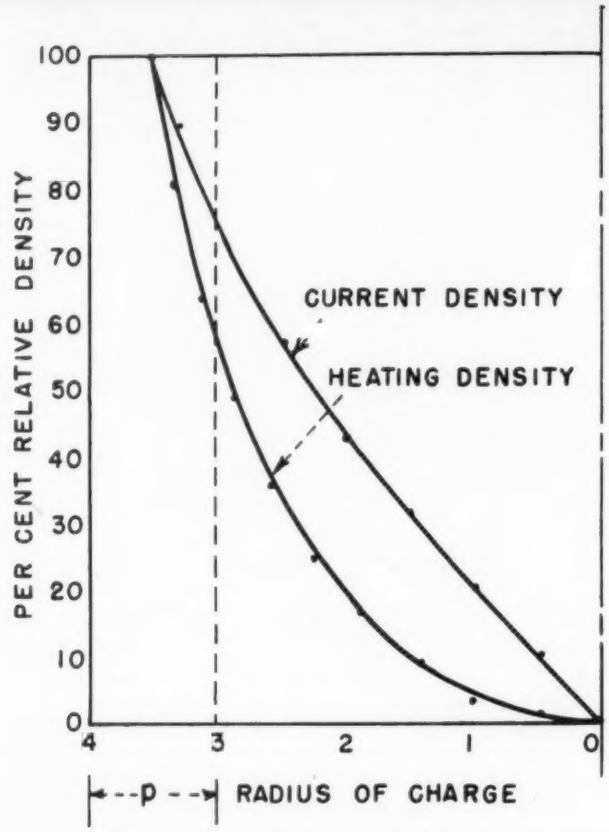
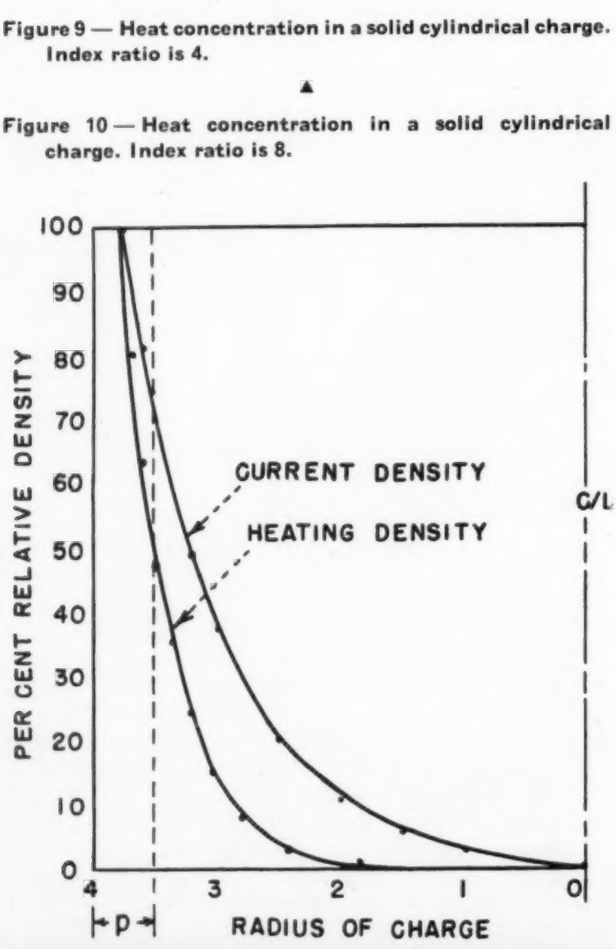


Figure 9 — Heat concentration in a solid cylindrical charge. Index ratio is 4.

▲

Figure 10 — Heat concentration in a solid cylindrical charge. Index ratio is 8.



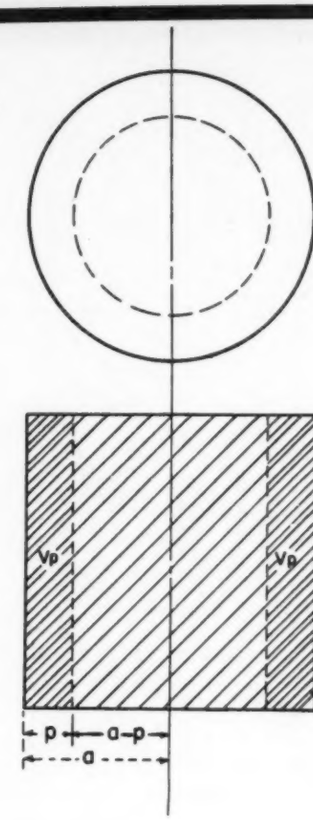


Figure 11 — Volume $\sqrt{p}$ diagram.

the volume V_p and the volume of a solid cylindrical charge for values of the index ratio.

The relations of Figure 12 and 13 are considered together in Table II. For example, with the index ratio 4 about 79 per cent of the heat is developed in the annular zone which constitutes 44 per cent of the volume of the charge.

TABLE II

Heat Concentration in Volume V_p

Index Ratio	Watts	Volume $\frac{V_p}{V_c}$
2	98%	75%
3	84	56
4	79	44
5	76.5	36
6	76	30
7	76	26
8	76	23
10	76	19

Electrical efficiency — The importance of the electrical efficiency of an assembly relates mainly to the effectiveness of the heating operation. The energy loss is an economic consideration which should be given weight according to the scale of the operation.

The electrical losses of an assembly are the $i^2 r$ loss in the primary coil and any loss caused by exposure of metallic parts, other than the charge, to the alternating magnetic flux. If the latter loss, which should be small, is neglected, the electrical efficiency of an assembly is:

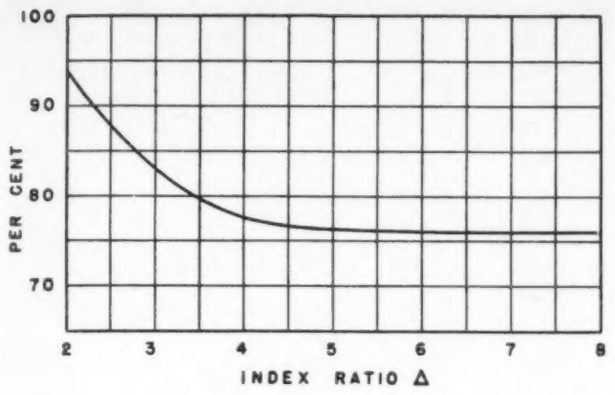


Figure 12 — Heat concentration in volume V_p for various index ratios.

$$\eta = \frac{r_a}{r_b + r_a} \qquad (4)$$

$$= \frac{r_a}{R}$$

r_a = the resistance of the secondary circuit, ohms
r_b = the resistance of the primary circuit, ohms
R = the effective resistance of the circuit, ohms

Resistivity-efficiency relation — The resistance of the primary circuit is independent of the value of the charge resistivity. The resistance of the secondary circuit is determined in part by value of the charge resistivity.

The graphs of Figure 14 show the effects of charge resistivity on the electrical efficiencies of two assemblies; one with a solid cylindrical charge, the other with a charge which has a thin rectangular section.

Note the inversion points on the graphs of Figure 14. These show that with values of the index ratio to the right of the inversion point in each case that an increase of charge resistivity is favorable to heat development, to the left unfavorable. This is because the resistivity is inversely proportional to the index ratio as illustrated in equations 2 and 3.

Frequency-efficiency relation — The graph of Figure 15 shows the effect of frequency on the electrical efficiency of an assembly with a solid cylindrical charge. There is no optimum frequency. With increasing frequency, the efficiency approaches a constant value, that value is taken to be 100 per cent for the graph of Figure 15. Generally it is stated that with solid cylindrical charges that there is no appreciable gain in efficiency by the use of frequencies which give values of the index ratio above about 5.

The corresponding graph for an assembly with a charge which has a thin rectangular section is shown in Figure 16. There is in this case a theoretical optimum efficiency as indicated by the graph. As the frequency is increased beyond the value which gives the maximum efficiency the efficiency decreases and becomes constant with the frequency which gives the index ratio value 2π. That value of efficiency is taken to be 100 per cent in Figure 16. The general statement is, as in the case of the solid cylindrical charge, that there is no gain in

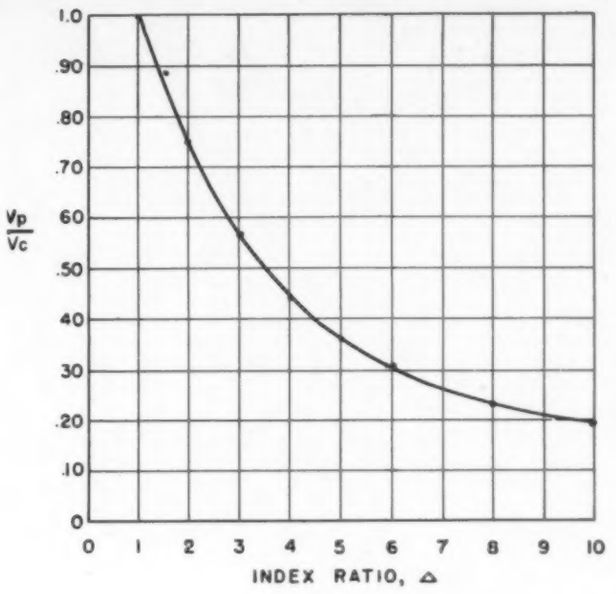
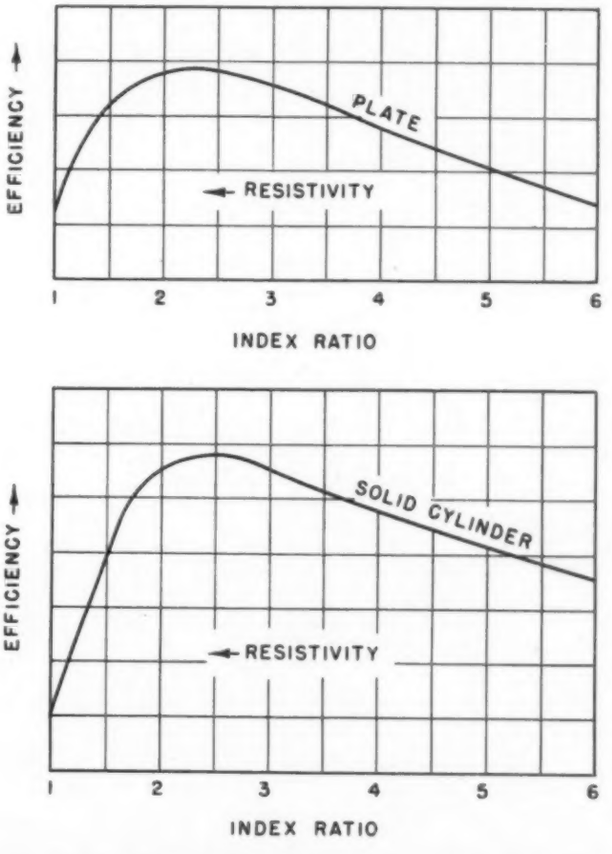


Figure 13 — Ratio of volume V_p and the volume of a solid cylindrical charge for various index ratios.

▲

Figure 14 — Resistivity-efficiency characteristics. The upper graph is for an assembly with a charge which has a thin rectangular section. The lower graph shows an assembly with a solid cylindrical charge.



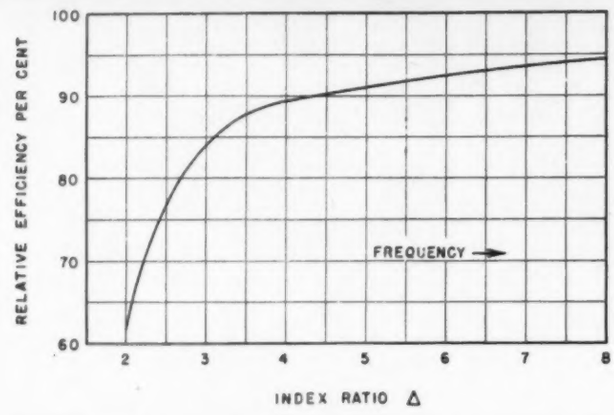


Figure 15 — Frequency-efficiency relations of an assembly with solid cylindrical charge.

efficiency by the use of frequencies which give values of the index ratio above about 5.

Thermal efficiency — The ratio of heat content of the charge and the sum of the heat content, electrical loss and heat loss from the charge during the heat cycle expresses the thermal efficiency of the heating operation.

Over-all efficiency — The thermal efficiency multiplied by the efficiency of the electrical apparatus gives the over-all efficiency. This value is expressed as pounds per kilowatt hour or kilowatt hours per ton according to the scale of the operation.

Power-factor — The power-factor of an assembly for induction heating is always less — and generally much less — than 0.707 because of the gap between the primary coil and the charge. The average power-factor of metal-melting furnaces is around 10 per cent. There is no corresponding average value for other assemblies because of the wide variety of the applications.

Technical and economic considerations require that the electrical load of induction heating be maintained at a power-factor near unity. The power-factor of an assembly decreases with increase of frequency. Hence, there is a corresponding increase of capacitance for unity power-factor operation.

Power — The input to the primary coil is

$$P_b = \frac{e^2 \cos \phi}{z} = \frac{e^2 R}{z^2} \text{ (watts)} \qquad (5)$$

The corresponding input to the charge is,

$$P_a = \frac{e^2 R}{z^2} \eta = \frac{e^2 r_a}{z^2} \text{ (watts)} \qquad (6)$$

e = the applied voltage
R = the effective resistance of the circuits, ohms
r_a = the resistance of the path of the current in the charge — the secondary circuit — ohms
z = the effective impedance of the circuits, ohms
$\cos \phi$ = the power-factor
η = the electrical efficiency

Power density — The unit of power density is watts per unit area of the lateral surface of the charge. That value cannot be measured directly. The corresponding value measured at the terminals of the primary coil and multiplied by the efficiency of the assembly must be used. The efficiencies of assemblies vary widely. Hence, stated values of power density for different assemblies are not comparable unless the efficiencies are given. Power density values must be considered with reference

Figure 16 — Frequency-efficiency relations of an assembly with a charge which has a thin rectangular section.

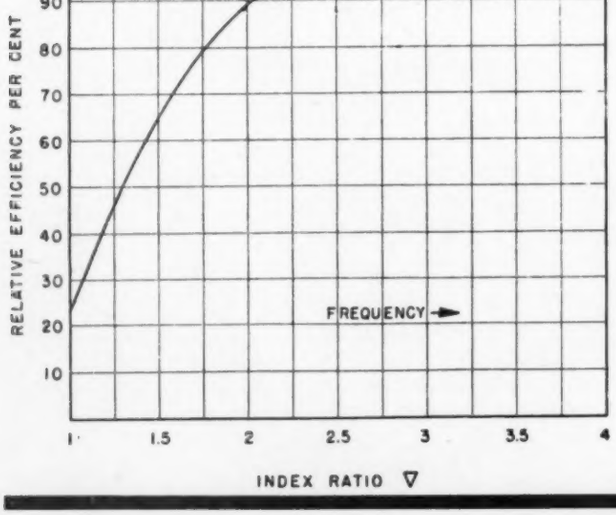
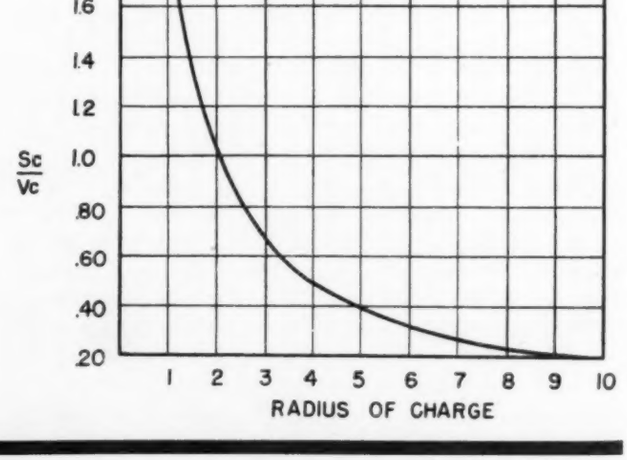


Figure 17 — Ratio of the area of the lateral surface of a solid cylindrical charge and its volume to the radius of the cylinder.



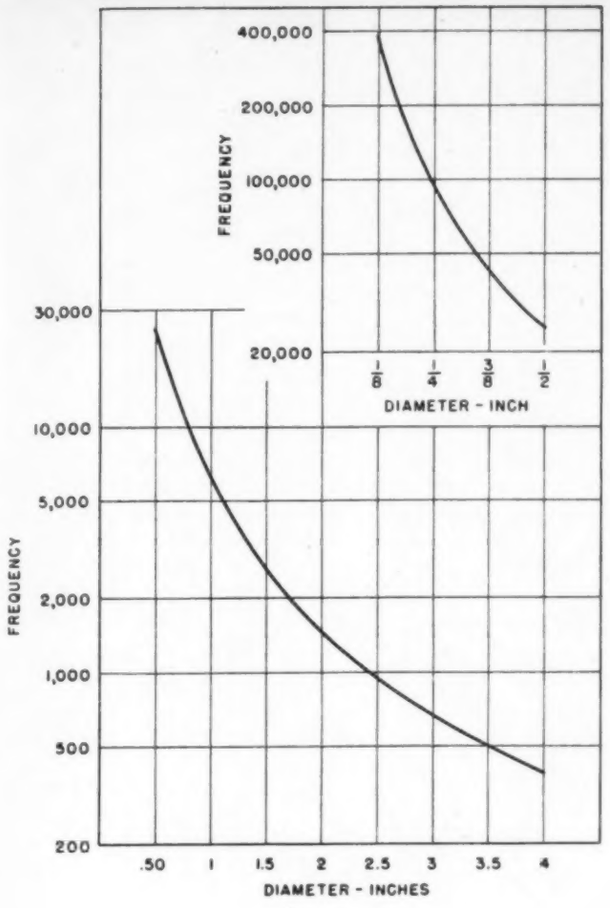


Figure 18 — Frequency-dimension relations of solid cylindrical charges. Charge resistivity 125 microhms centimeter cube. Index ratio 2.50.

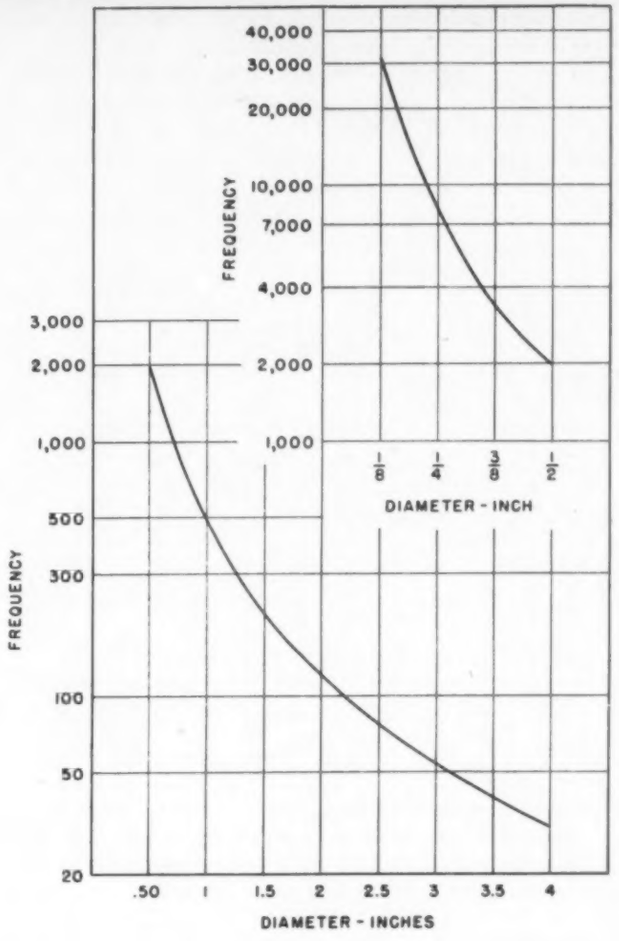


Figure 19 — Frequency dimension relations of solid cylindrical charges. Charge resistivity 10 microhms centimeter cube, $\mu = 1.0$. Index ratio 2.50.

to the heat concentration, Table II, and to the surface-volume relation of the charge.

Surface-volume relation — The ratio of the lateral surface area of a solid cylindrical charge and its volume is:

$$\frac{S_c}{V_c} = \frac{2}{a} \qquad (7)$$

a = radius of the charge

A graph of this ratio is shown in Figure 17. For example, if the diameter of the charge is 1 inch there are 4 square inches of lateral surface for each cubic inch of charge volume. If the diameter is 4 inches the value of this ratio is 1.0. Similar considerations apply to other shapes of charges.

APPLICATIONS

The unique feature of an assembly for induction heating is the absence of terminals attached to, or electrodes in contact with, the charge. That feature and the stipulation that the charge be of conductive material define generally the field of the applications of the inductive method of heating.

Service — Induction heating is used for two classes of service, namely,

(A) Heating solids to temperatures below the melting point of the material.

(B) Melting metals. The last stage of this service is the heating of a liquid conductor.

Only class A service is included in this discussion. A distinctive feature of this service is that there is no heat stored in the structure of the assembly.

Methods — The two methods of heating in class A service are:

(a) Mass heating, as for forging, annealing, etc. The term implies the attainment of a uniform temperature throughout the mass of the charge.

(b) Surface heating, such as heating steel for hardening, heating for some types of brazing, etc. The heat effect is required only in the surface zone of the charge.

Standard frequencies — The frequencies in general use for induction heating are 960, 3,000 and 9,600 cycles obtained with rotating machines and 450 kilocycles (nominal) obtained with electronic apparatus. These frequencies because of usage are designated as standard frequencies.

Selection of frequency — The technical criterion for the selection of frequency for a given application in class A service is the frequency-efficiency characteristic of the assembly. Economics usually dictate the use of a

standard frequency nearest the technical choice. Generally those conditions are met for the two shapes of charges herein considered as follows.

(A) Solid cylindrical charges. A standard frequency which gives an index ratio within the range 2.50 to about 5, see Figure 15.

(B) Charges with thin rectangular sections. A standard frequency which gives an index ratio within the range 1.70 to about 5, see Figure 16.

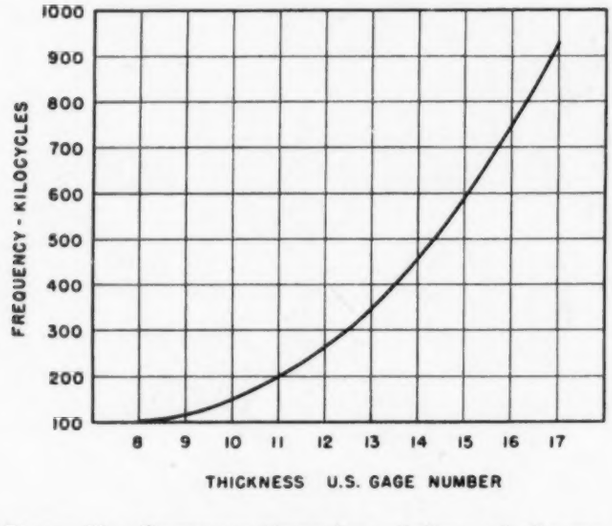
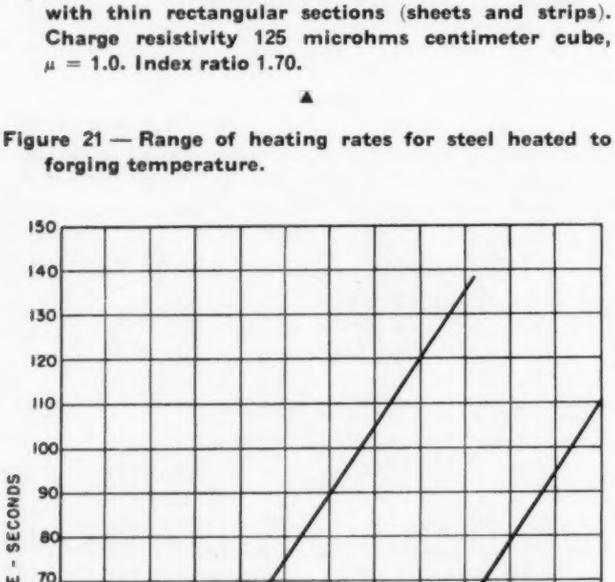


Figure 20 — Frequency-dimension relations of charges with thin rectangular sections (sheets and strips). Charge resistivity 125 microhms centimeter cube, μ = 1.0. Index ratio 1.70.

▲

Figure 21 — Range of heating rates for steel heated to forging temperature.



The value of μ in equation 1 for Type II charges is problematical. Usually this value is some fraction of the saturation value. Also there is the added effect of hysteresis which depends on temperature.

The value of μ in equation 1 for Type III charges is unity for both batch heating and continuous heating. In batch heating the effect of permeability is an initial boosting of the rate of heat development, generally about two to one. In continuous heating the entrance end of the primary coil operates under the condition of a Type II charge and the exit end under the condition of unit permeability. Thus the average effect of permeability on the rate of heat development is the average value that would be obtained in batch heating of the same material.

Judgment relative to the helpful effects of permeability and hysteresis with Types II and III charges can be used toward the selection of a frequency which would be lower than desirable for a nonmagnetic charge. The choice of a higher frequency in a given case than the upper limit noted is mainly a matter of economics.

The investment charge of electrical apparatus is not a linear relation with respect to frequency. In some cases that may be a consideration. Generally there is no technical objection to a frequency thus selected which is higher than otherwise would be desirable.

The economics of plant operation may be the decisive factor in the selection of frequency. In some cases there is a range of diameters, or thicknesses, of charges of a given material. There may be charges of different materials. In such cases one frequency which is effective for the entire range of work is desirable.

The graphs of Figure 18 show values of frequency and the corresponding diameters of solid cylindrical charges on the basis of the charge resistivity value 125 microhms centimeter cube, unit permeability and the index ratio 2.50.

The graphs of Figure 19 are for the data of Figure 18 except that the charge resistivity value is 10 microhms centimeter cube.

The graphs of Figure 20 are for charges with thin rectangular sections, sheets and strips, and are based on the charge resistivity value 125 microhms centimeter cube, unit permeability and the index ratio 1.70.

The frequency values of these three illustrations are intended for reference only.

MASS HEATING

Power density — The values of power density in practice vary over a wide range because of the wide variety of charges — nature, shapes, and sizes and because of differences in heating practice. Representative values are within the range 100 to 1,000 watts per square inch. Generally such values as given are primary values and in each case should be considered with reference to the efficiency of the assembly. The power density for a given charge is selected to give the desired rate of heating.

Heating rates — Temperature uniformity throughout the mass of the charge is attained by thermal conduction. In the case of a large charge, the diffusivity (or thermometric conductivity) of the material of the charge is a factor in the rate of heating. This may mean some

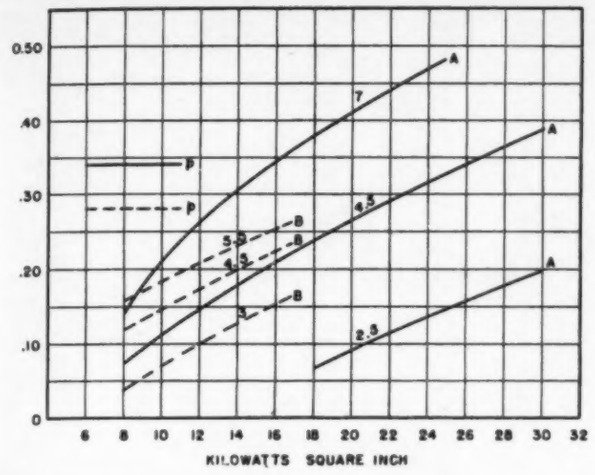


Figure 22 — Curves showing power required for induction heating for hardening steel. δ = depth of hardened zone to Rockwell C 50.

compromise between heat concentration and efficiency. An example is the use of an index ratio value of 3 for a large solid cylindrical charge.

As a rule a charge can be heated by the inductive method faster than is sanctioned by either metallurgical or economic engineering. Generally the best practice is a heating rate with which the flow of parts through the plant is continuous during the working period.

The ranges of rates of heating steel for forging which have been observed in practice are shown in Figure 21.

Energy — The electrical efficiencies of assemblies vary widely. The maximum value is obtained with a long primary coil and the minimum gap between the primary coil and the charge. That value with a copper primary coil and a steel charge at forging temperature may approach 90 per cent. The average value of practice is much below 90 per cent.

The overall efficiency varies with the temperature of the charge and the efficiency of the electrical apparatus. A reference value for metals heated to forging temperature is 4 to 6 pounds per kilowatt-hour.

Moving strip — The heating of fast-moving steel strip by the inductive method to moderate temperatures, say up to 240C (464F) is a comparatively simple application because of the beneficial effects of the magnetic property and of the low rate of heat loss from the strip. However, induction heating for moving steel strip to temperatures above the Curie point is a joint electrical and mechanical problem that has not been solved.

SURFACE HEATING

Hardening steel — With batch heating the term localized surface heating is often more descriptive. A feature of practice is a high power density and a short time, measured in seconds, of power application. There are no general rules except the observance of the principles noted in previous paragraphs. Each case is an individual study of a particular steel for a given service, of the heat concentration, of the surface-volume relation, and of the method of quenching. This being done the attainment of the desired result is much facilitated by the ease of control of the applied voltage (power density) and of the time of power application.

The chart of Figure 22 brings together some data from papers by Seulen and Voss[2], curves A, and by Vaughn, Farlow and Meyer[3], curves B. The ordinates of the curves are the depths of the zones hardened to Rockwell C 50. The time periods of the power applications are noted on the curves.

The data pertaining to this chart are:

Charge	Curves A	Curves B
Analysis	0.35C, 1.25 Si, 1.2 Mn	SAE-1045 (0.45C)
Diameter	2.75 in.	1.5 in.
Frequency	2,000 cycles	3,000 cycles
Reference dimension	0.87 cm (0.34 in.)	0.71 cm (0.28 in.)
Index ratio	4	2.65

Although the conditions are not the same, the two sets of data are sufficiently well related for a comparative study.

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Conservation of Fuels

. . . . these discussions formed part of a symposium on fuel conservation which was held under the chairmanship of L. R. Milburn, of Great Lakes Steel Corporation, who was also a member of the Fuel Efficiency Council ofthe Coordinator's Advisory Committee for the Detroit area . . . . although the stress of war shortages has relaxed, fuel conservation is at all times desirable and profitable . . . .

by A. C. Pasini and *C. R. Miller*

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CONSERVATION OF COAL

by A. C. Pasini

▲ CONSERVATION of coal is one of the nation's most important duties. A study of Figures 1 and 2 will indicate how important it is to conserve coal. During the war production did not meet the demand and stock piles dwindled. Authorities have stated that 20 per cent of all fuel burned in small industrial plants and up to 40 per cent of that burned in the average heating plant is wasted.

Coal is a complex substance consisting of many different constituents, few of which are thoroughly known. It is derived entirely from plants which are of complex nature, involving a large number of chemical forms. In the study of coal a knowledge of where it comes from is essential but space does not permit investigation of this subject here.

The chemistry of combustion, while involved, can be reduced to a few general principles. Combustion is the phenomenon resulting from any chemical combination evolving heat. Oxygen is the sole supporter of combustion and a combustible, therefore, may be defined as a substance capable of combining with oxygen to produce heat. Combustion is complete when the elements and compounds have united with all of the oxygen with which they are capable of entering into combination.

Atmospheric air is a mechanical mixture of oxygen and inert gases. Air contains 21 per cent oxygen by volume and 79 per cent nitrogen by volume. The nitrogen serves no useful purpose and is a source of direct loss because it absorbs heat in its passage through the furnace. The heat energy evolved in the furnace by the union of oxygen and combustible elements is dependent on the final products of combustion leaving the furnace and in no way on any intermediate steps.

Carbon and sulphur are the only elements in coal in a free state and their presence in any other state spells a loss. The temperature of a flame is dependent on the Btu produced and the weight of the products of combustion.

Presented before A. I. S. E. Detroit District Section Meeting, November 14, 1945.

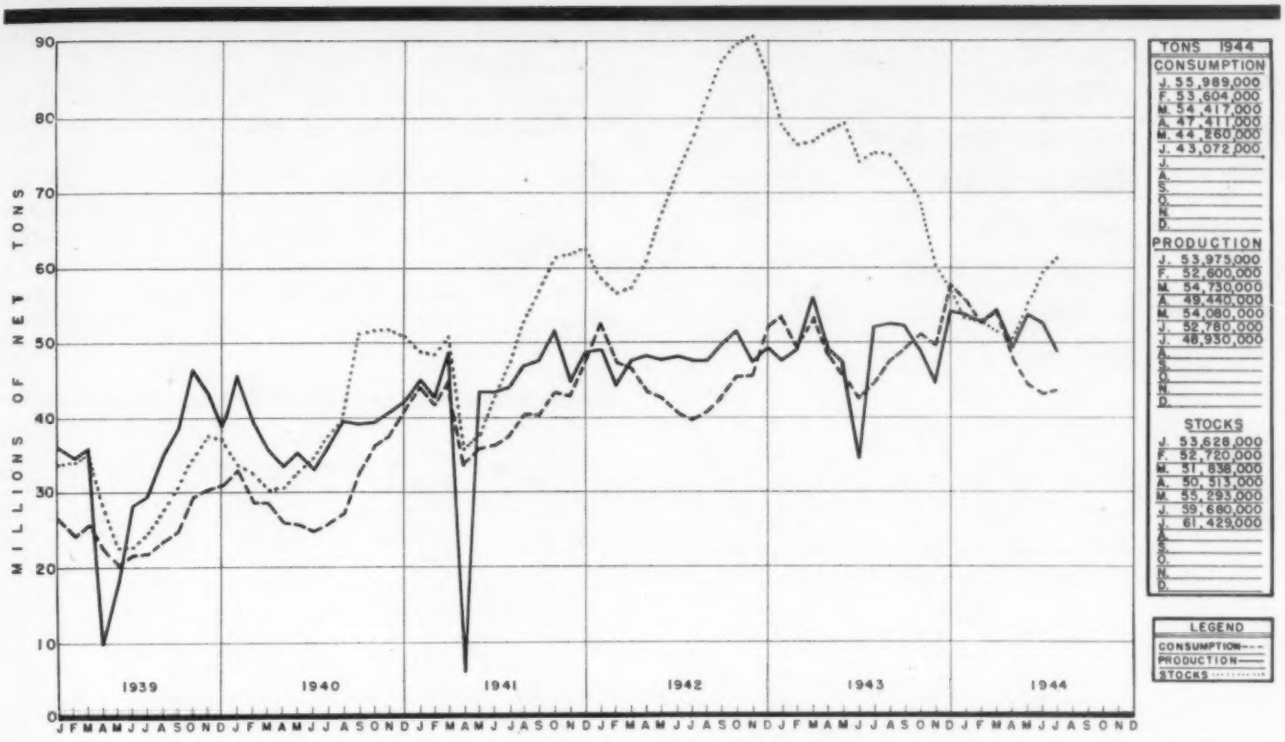


Figure 1 — Trends in production, consumption and stocks of bituminous coal.

For every lb of oxygen, 4.3 lb of air are required of which 3.3 lb are of no use. For the complete combustion of one lb of carbon, 11½ lb of air are required, of which approximately 9 lb are of no use. So to begin with, we are at a disadvantage because of the tremendous volumes required to obtain the oxygen necessary for the burning of coal.

In view of the great number of factors involved in the combustion of fuel, particularly coal, it is obvious that the specific requirements for proper combustion of an individual fuel must be considered a distinct problem. It is possible to draw certain general requirements for proper combustion and they are as follows:

1. The admission of an air supply such as will assure sufficient oxygen for complete combustion.
2. Since complete combustion is not necessarily efficient combustion, it must be secured without permitting the dilution of the products of combustion with excess air. Therefore, it follows:
3. That the air supply must be admitted at the proper time, in the proper amount, and in such a manner that the oxygen comes into free and intimate contact with the combustibles.
4. The gases must be maintained at a temperature at or above their ignition point.
5. Proper provision must be made for the expansion of the gases during the period of their combustion.

In a fuel bed, whether hand-fired or stoker-fired, there are three distinct zones:

1. The volatile zone, where the combustible gases must be permitted to escape and mix with the air.
2. The coking zone, where coking and burning take place.
3. The zone of residue, where complete burning of the carbon is effected and the residue discharged.

Figure 3 indicates the three zones. If improper combustion takes place, CO is formed and the heat energy liberated is approximately 4,400 Btu per lb of carbon. If complete combustion is effected CO_2 is formed and the heat energy liberated is approximately 14,600 Btu per lb of carbon. So it is important that the amount of air entering the fuel bed must be properly controlled. The following figures show how efficiency varies with temperature and CO_2 content of the waste gases:

TABLE A

CO_2 of	6%	8%	10%	13%
At 700 F	52%	58%	63%	71%
At 500 F	66%	70%	73%	79%
At 300 F	79%	86%	81%	83%

Proper firing is not the whole problem. Savings can be effected as follows:

TABLE B

	Atlanta	Detroit	Minne-apolis	Seattle
Average Winter Temperature	50.1	40.9	36.2	50.9
Per cent of additional fuel required (above 70 F base)				
to maintain 71 F	5.03	3.44	2.96	5.24
75 F	25.15	17.20	14.80	26.20
80 F	50.3	34.4	29.6	52.4
Per cent of saving by lowering night temperatures 10 F for:				
8 hrs	16.16	11.12	9.60	16.80
12 hrs	24.24	16.68	14.40	25.20

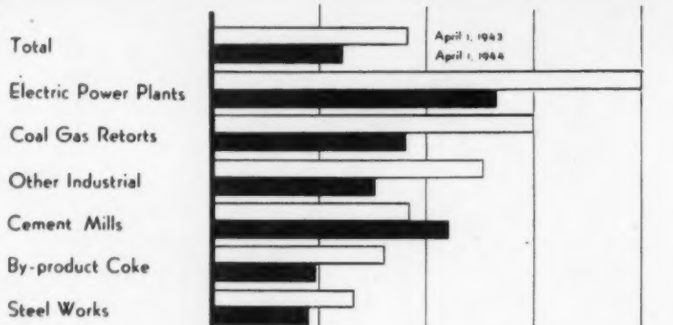
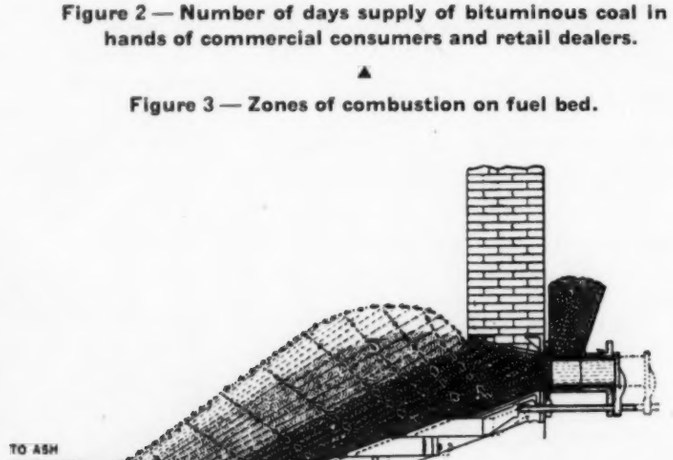


Figure 2 — Number of days supply of bituminous coal in hands of commercial consumers and retail dealers.

▲

Figure 3 — Zones of combustion on fuel bed.



1. Controlled building temperature can effect savings as follows:
2. Considerable saving can be made by keeping the heating surfaces clean so that the maximum heat absorption can be effected.

In undertaking a program to save coal, the following suggestions will prove of assistance for maintaining the equipment in proper working condition:

1. In fire tube boilers, clean all tubes thoroughly of accumulated soot and dirt.
2. In water tube boilers, clean all tubes on the fire side thoroughly.
3. In hot air heating systems, clean fire side and air side thoroughly to remove dirt and soot.
4. Clean all water sides of heating surfaces.
5. Use a candle or torch to check all boiler settings, breeching, outlet connections, and doors for air leaks. Caulk or plug all leaks.
6. Inspect and test all steam lines for leaks and for heat losses, by radiation. Repair leaks and insulate exposed piping.
7. In heating plants, inspect and test all radiator valves, vents, traps, vacuum lines and pumps.
8. Check chimneys.
9. Institute definite and rigid cleaning schedules.
10. Institute performance and fuel consumption standards.
11. In the larger heating plants, do not be afraid to install instruments such as draft gages, pressure gages, etc. These instruments will pay for themselves if properly applied.

Careful consideration and diligent application of the points discussed will enable even an untrained person to effect a savings.

DISCUSSION

PRESENTED BY

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A. C. PASINI, Technical Engineer, The Detroit Edison Company, Detroit, Michigan.

C. M. SMITH, Plant Engineer, Rotary Electric Steel Company, Detroit, Michigan.

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H. A. CLARK, Industrial Engineer, Michigan Consolidated Gas Company, Detroit, Michigan.

H. F. Lesso: In an article published in the Mining Congress Journal there were figures showing the United States Government purchases of coal in 1939 totalled five million tons. In 1943 the total tonnage purchased had increased to ten million tons. The resulting reduction in the amount of coal available for industrial and domestic consumption naturally suggested the need for improving the efficiency with which coal and other fuels were used in industry and home heating.

Since there has been some discussion on the relative efficiencies of the various fuels, I have been wondering if there are any available data indicating the maximum efficiencies which have been attained or what improvements in efficiencies have been realized in our industrial and domestic consumption and to what extent mechanical devices have been responsible for such improvement? Are there any data, Mr. Pasini, that indicate these relative efficiencies?

A. C. Pasini: Yes, considerable data are available. One can take coal in a stoker-fired domestic furnace and burn it with a relative efficiency of 88 per cent. On the other hand, with the same coal and the same furnace without the stoker, the efficiency can drop to 40 per cent.

You can take oil and with the proper equipment, burn it just as efficiently, if not a little more efficiently, than coal. I believe the same condition applies to gas. A determination of the combustible gases is excellent but the correct interpretation is necessary.

With coal, 15 per cent CO_2 is good; but to the oil man 11 per cent is good, and eleven per cent with oil is better than 15 per cent with coal, because of the nature of the fuel being burned.

I can recall tests made several years ago, comparing hand-fired coal, mechanically-fired coal, automatically-fired coal, oil, and gas. There wasn't much to choose between the coal, the oil, and the gas, if the proper automatic equipment was used. However, hand-fired coal made a very poor showing by comparison.

H. F. Lesso: Have coal quality specifications been modified in any way during the war?

A. C. Pasini: Yes. For example, in our plants our coal normally had a heating value of 14,500 Btu with seven per cent ash. In 1944, our coal had a heating value of 13,000 Btu with 15 per cent ash. Oil is more constant in quality and would give better results than coal because of this factor.

C. M. Smith: I would like to hear something about insulation.

A. C. Pasini: This is a very important matter. If you allow a square foot of steam piping to be uninsulated for an ordinary Detroit season, you can figure on a loss of 168 pounds of coal per square foot. It is also very important that you insulate return lines. In our high-pressure plants where we generate steam at high pressure and high temperature, we find that it is necessary to spend thousands of dollars to insulate our steam lines. For instance, we use one inch of what we call high temperature insulating material next to the pipe surface, plus another 1½ in. of 85 per cent magnesia. If we left that 1½ in. of 85 per cent magnesia off, and just used the high temperature insulation the equivalent of five thousand tons of coal would be lost every year in one plant alone. Another place we insulate is the steam generator. A heat-loss test on an uninsulated steam generator producing four hundred thousand pounds of steam per hour, shows at least a five per cent loss. When burning forty tons an hour in this furnace, a loss of two tons per hour results.

C. M. Smith: How do you insulate steam lines underground?

A. C. Pasini: There are several ways. Small pipes need not be insulated except with tar paper, and painted with a coat of asphalt. Years ago we ran some experiments on insulating pipes in the ground, and we found out that if we buried the pipes below the frost line, ordinary tar paper and asphalt did a pretty good job. For larger lines insulation comes into the picture. Proper drainage is very essential.

P. E. Haglund: I have been hearing a lot about the different fuels, and it seems to me most of the waste is excess air. Without a lot of scientific instruments, which would be the best way to know when the right amount of air is used to burn the fuel?

A. C. Pasini: Two simple things will tell that. If the fuel bed is thin with the coal particles "popping" off like popcorn, then there is plenty of excess air.

The other way is to check the furnace and eliminate all air leakage, so that the only air that will get into that furnace is what is necessary for proper combustion.

Those are two very simple rules, which eliminate worrying about expensive instruments. But in the larger heating plants, or even small heating plants, there is one instrument that will tell you if you have the correct amount of air, providing you have got a tight furnace and are carrying the proper fuel bed. That instrument is a draft-gauge in the stack or in the furnace.

If you have a draft-gauge and it shows 0.1 to 0.3 in. water draft in the furnace, you are using too much air. If you maintain a draft of 0.01 to 0.03 of an inch of water and get a clean fire without smoke, then there is good combustion.

H. A. Clark: If you set up a simple temperature-measuring device at the beginning of the stack, and the temperatures were, say, 500 degrees, would it mean that you had incomplete combustion or a badly designed furnace?

A. C. Pasini: If you measured the temperature at the stack of an ordinary furnace and you found you had 500 degrees, one of two things is occuring. You have either too much excess air or proper absorption of the heat energy is not taking place. The first thing to do is burn out the furnace and examine the water side to see if it has scale. No doubt there will be plenty of scale. Also, examine the fire side, and you will probably find a lot of soot. The scale and soot should be removed. Check the furnace before shutting down to make sure there are no air leaks. The simplest way is to use a candle going over the joints and fire doors, and marking the places the flame is "pulled-in," and then repair those places. When the furnace is started again, there will not be any 500 degrees at the stack. When you consider that every 40 degrees reduction in exit gas temperature is equivalent to a reduction of one per cent in fuel consumption, you can see what a tremendous saving is effected.

CONSERVATION OF FUEL OIL

by C. R. Miller

▲ IN looking at the overall picture of the national fuel problem, it is well to give careful consideration to the position occupied by fuel oil. After all, we can consider fuel oil as being coal in liquid form and, as such, it has a number of advantages over coal which might be interesting to mention.

Fuel in liquid form is much easier to transport than is an equivalent amount of coal. Oil may be delivered by rail, tank ship or pipe line and, for a given amount of space occupied, more energy in the form of Btu is transported in oil than is the case with coal. It is easier and more convenient to handle. It is more adaptable to the use of automatic burning equipment and, as a rule, less man-power is required to burn a ton of oil as compared with that required to burn a ton of coal. In addition, there is no problem involved in the disposition of ash.

In the latter part of 1944, the United States was producing approximately four and one-half million barrels of oil per day. This is equivalent to approximately seven hundred thousand tons of oil. Of course, all of this is not available as fuel oil. The major portion of it is converted into such products as gasoline, distillates, lubricating oils, waxes, etc. We can estimate, however,

Figure 1 — Chart above gives viscosity-temperature relationships for several liquid petroleum products.

that approximately 20 per cent of it, or one hundred forty thousand tons a day, is represented by a residual fuel oil which is available for use in industrial plants as a supplement to solid fuel. Here, then, is an excellent opportunity for helping to solve coal shortages in a most effective manner.

Already a great quantity of oil is being used for heating homes, apartment buildings, theatres, churches, office buildings, etc., and this alone gives some realization of what we would face if oil were not available for this purpose.

The possibility of expanding the use of oil is very great. There are still a great number of installations, such as large office buildings, hospitals, etc. where coal is still being used and in a great number of cases the burning of coal is being handled through installations that are extremely inefficient. We have only to look at the smoke stacks of such installations to realize this fact.

With a modern oil burner, oil can be burned much more effectively, with less problems involving the production of smoke, soot and ashes, and with considerably less man-power than is the case where solid fuel is being used. Great strides have been made in recent years in perfecting equipment for the proper handling of oil for such purposes.

The transportation system has already been touched upon and after the oil is delivered to its destination, we are faced with a number of simple problems involving its proper utilization. An installation for the use of oil calls for, first, the necessary storage tanks with proper facilities, such as unloading lines, pumps, etc.

The next step is to provide equipment for preparing the oil for combustion and for bringing about its ultimate combustion with the subsequent release of its energy in the form of heat. The successful use of oil depends to a very large extent upon the design of the equipment involved and upon the maintenance and control of its operation.

There are a number of important factors which must be considered. First, the storage tank should be equipped with facilities for keeping the oil warm if it happens to be located at a point where it is exposed to extremely low temperature conditions. This may mean that the tanks should be insulated and perhaps, where there is steam available, they should be equipped with coils through which the steam can be circulated to keep the oil warm.

The fundamental basis on which oil is prepared for combustion is simply a matter of atomization. The chemical action in bringing about combustion is pretty much the same as that of any other fuel. Oil is a chemical combination of the elements of carbon and hydrogen, and both of these are highly combustible; providing they are supplied with a sufficient quantity of oxygen to bring about the desired result. In order to accomplish intimate contact between the oil and oxygen or air, it is necessary that the oil be broken up into extremely fine particles.

Each particle then is surrounded by air and when the temperature is raised to its ignition point, it readily begins to burn and the chemical action which we term combustion takes place. The carbon theoretically burns to a final product, carbon dioxide, and the hydrogen to water. Both of these are in vapor form at the conclusion of combustion and are carried through the flues and up the stack to the outside air.

The extent to which atomization is accomplished determines to a great extent the efficiency with which the oil will burn in the combustion chamber. This, of course, is controlled largely by the mechanical device used to bring about this action.

The ease with which oil can be broken up or atomized depends to a very great extent upon its viscosity. Viscosity is a measure of fluidity, internal friction or, in common terms, the thickness of the oil. The less viscous it is, the more effectively it can be atomized. However, most of our residual fuel oils are quite viscous, and in such a condition it is not always possible to break them up by mechanical means and prepare them for combustion. The result will be inefficient burning and wastage of fuel.

However, this can be readily overcome by preheating and raising the temperature of the oil before it reaches the burner. We know that the higher the temperature at which the oil exists, the lower will be its viscosity and the thinner it becomes. In this condition it is more readily atomized and so it is essential, where the heavier grades of oil are being used, to apply sufficient heat in the storage tank or by auxiliary heaters in the lines circulating the oil, to heat the oil to the point where its viscosity becomes sufficiently low for easy atomization.

The installation of an auxiliary heater in the line is relatively simple, and it heats only that oil which is being circulated to the furnace. There is little or no waste of heat on this account because the heat in the oil going to the furnace is utilized in the final temperature produced in the combustion chamber.

Some users of fuel oil make the mistake of attempting to burn oil without first preheating it. This results in the oil not being completely burned, with lowered efficiency as a result. It also makes it necessary for the user of the oil to purchase a less viscous grade, for which he has to pay more money and from which he gets a lower Btu.

We are familiar with some installations where this has been done for a number of years, and the user of the oil has penalized himself many thousands of dollars which could have been used effectively to put in proper equipment, with a resultant saving in ultimate cost.

It is advisable, therefore, that anyone using fuel oil at the present time should make a careful survey of his equipment to determine whether it is in the best condition possible for the proper utilization of heat units contained in a gallon of oil. He then should make any necessary corrections in his equipment so that he may be able to take advantage of heavier oil containing more heat units and which, paradoxically, sells for a lower price per gallon.

It is interesting to note, as an illustration, that the average heaviest grade of fuel oil will contain as high as 155,000 Btu per gallon, while another grade that is less viscous might contain only 150,000 Btu per gallon, a third grade might contain 145,000 Btu per gallon and a fourth as low as 140,000 Btu per gallon. Strange as it may seem, the latter oil will cost more per gallon, delivered to the user's tanks, than will the first one which contains considerably more in the way of heating value.

The factor of oil temperature at the burner is a major consideration in deciding what kind of oil can be used most advantageously. Other factors, such as the construction of furnaces, combustion chambers, etc. are just as important in burning oil as they are in burning coal or gas, and anything which might be said about the nature and condition of furnace and other accessories for using other fuels will apply equally to oil. In other words, heat losses through furnace walls or up the stack, etc. can be just as great when burning oil as when burning coal.

Under the circumstances, it would seem that oil offers a number of advantages that will compensate for any additional cost involved in the installation of equipment. The use of oil in all sorts of installations has been effective to the point where there are few, if any, insurmountable problems involved. The oil industry stands ready at any time to assist the users of fuel oil in the solution of any problems which may arise.

DISCUSSION

PRESENTED BY

G. A. FERRIS, Metallurgical Observer, Ford Motor Company, Dearborn, Michigan.

C. R. MILLER, Consulting Engineer, Socony-Vacuum Oil Company, Detroit, Michigan.

C. M. SMITH, Plant Engineer, Rotary Electric Steel Company, Detroit, Michigan.

G. A. Ferris: I might ask Mr. Miller what experience he has had with sludge solvents in regard to oil.

C. R. Miller: The so-called sludge solvents never appealed to us, largely because of the fact that we know we have installations where many, many thousands of gallons of fuel oil are being used without any sludge solvent and without any trouble.

We find that, where sludge is liable to collect in a storage tank, one of the most effective methods of disposing of it is to apply heat to the oil, and the water will drop to the bottom.

We also find that a great number of the so-called sludge solvents are largely naphthalene, which you can buy for a few cents a pound, but which in the form of sludge solvents is extremely expensive. The introduction of some naphthalene into a tank will break the emulsion and allow the oil or water and sludge to settle out.

Of course, provisions should be made on all storage tanks for draining them carefully, because fuel oil is not a highly refined product and may be delivered with a trace of water in it. Then as the years go by, there is a certain amount of condensation or moisture from the air that collects in the tank, and provisions should be made for its removal.

I know of one occurrence a number of years ago, where several hundred thousand gallons of fuel oil were in storage tanks of a company that was burning oil. The oil would not burn, and examination showed it contained about one half of one per cent of water. We found that by transferring it to a tank which was equipped with steam coils and applying heat to it, the water was eliminated and the oil made a perfectly good fuel from there on. Whereas they had considered gradually dumping it on the coal pile and disposing of it that way, they finally went ahead and burned all of it in the usual way.

C. M. Smith: I would like to ask what temperature oil should be heated to for good atomization.

C. R. Miller: That depends to a large extent on the viscosity of the oil. Normally we use a heavy, residual type oil, and I am not speaking of distillates or domestic oil, for you do not have to heat them. The average industrial oil can be safely and effectively heated to 140, 150 or 160 F.

I have charts which show the viscosity drop coincident with any given temperature. On the average oil that is supplied in the Detroit area the maximum viscosity will run in the neighborhood of 1,500 ssu at 100 F. If that oil is heated to 140 or 160 F, there will be a sufficient viscosity drop so it can be readily atomized and burned in any well engineered burner on the market today.

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Developments IN STANDARDIZATION DURING 1945

by Frank W. Cramer, CHAIRMAN
A. I. S. E. STANDARDIZATION COMMITTEE

▲ DURING 1945 the trend to standardization continued with resulting economies in operation because of reduced inventories, larger discount rates and the greater familiarity of maintenance and operating men with the equipment involved. The work is being done by many organizations, among whom those having the greatest interest to the Association of Iron and Steel Engineers are the American Standards Association, the National Electrical Manufacturers Association, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Society of Testing Materials, and of course, the Association of Iron and Steel Engineers itself. Most of the work of the American Standards Association is sponsored first by a manufacturer's association or an engineering society, and then, after review, adopted by the ASA as an American Standard. In the following report, brief comments will be made on some of the more important projects; for those interested, further reference should be made to the standards themselves.

AMERICAN STANDARDS ASSOCIATION

The "American Standards for Alternating-Current Power Circuit Breakers," sponsored by the Electrical Standards Committee was approved by the ASA in May and has been published in a single paper bound publication numbered C 37.4–1945 through C 37.9–1945. This is the third such project completed by the ASA Sectional Committee on Power Switchgear.

For the purpose of this standard, a-c power circuit breakers are defined as those of the following which have rated voltages higher than 600 volts:

a. Oil circuit breakers.
b. Circuit breakers using liquids other than oil.
c. Air circuit breakers.

Most oil circuit breakers and high voltage a-c circuit breakers of the oilless type are covered.

The following American Standards are bound in the same publication:

a. Alternating-Current Power Circuit Breakers, C 37.4–1945.
b. Method of Determination of RMS Values, C 37.5–1945.
c. Schedule of Preferred Power Circuit Breaker Ratings, C 37.6–1945.
d. Operating Duty (Duty Cycle) for Standard and Reclosing Service, C 37.7–1945.
e. Rated Control Voltages, C 37.8–1945.
f. Test Code for Power Circuit Breakers, C 37.9–1945.

The tables in the publication have eliminated some of the previous recommended ratings. However, the tables include voltages for future, contemplated, voltage ratings. A novel feature of the standards is the tables of preferred circuit breaker ratings. The tables are sub-divided into four:

a. Table 1. Indoor Oil.
b. Table 2. Indoor Oilless.
c. Table 3. Outdoor Oil.
d. Table 4. Outdoor Oilless and Low Oil Content.

These tables form a complete guide to the selection of circuit breakers. A section of Table 2, Indoor Oilless Power Circuit Breakers, is given herewith (see Table A), as it is of particular interest to steel mill engineers. The ratings in ordinary type are those now available. Those in italics are listed as a guide for future development.

The so-called one-line diagram, consisting of single lines and simplified standard symbols which indicate the course and component elements of an electric circuit or system of circuits, continued to gain in usage. The

TABLE A

Line No	Operating Voltage Insulation Level Current Ratings in Amperes Interrupting Ratings									
	Rated kv	Min. kv	Withstand test		Continuous 60 cycles	Short time (5)		3 phase rated kva	Amperes at rated voltage	Max. amperes
			Low frequency RMS kv	Impulse crest kv		Momentary	5 second			
15	*75*	*40*	*26*	*75*	*600*	*40,000*	*22,000*	*150,000*	*11,500*	*22,000*
16	*75*	*40*	*26*	*75*	*1,200*	*45,000*	*22,000*	*150,000*	*11,500*	*22,000*
17	75	40	36	95	1,200	60,000	36,000	250,000	20,000	36,000
18	75	40	36	95	2,000	70,000	36,000	250,000	20,000	36,000
19	75	64	36	95	1,200	80,000	45,000	500,000	40,000	45,000
20	75	64	36	95	2,000	80,000	45,000	500,000	40,000	45,000

system was published as an American Standard in ASA publication Z 32.3–1943, "Graphical Symbols for Power, Control and Measurement," and was sponsored by the AIEE and ASME. However, the publication is being revised because of some inconsistencies with the American War Standard, published as Z 32.11–1944, "Coordination of Electrical Graphical Symbols (American War Standard)." The adoption of this system, with perhaps some minor changes, appears inevitable. The code was prepared by a committee composed of representatives of the electrical manufacturers, users of electrical equipment and educators, and was based on experience with the American Tentative Standard for a 10 year period.

The symbols are generally simple and arbitrary rather than pictorial, which simplifies reading and writing. The list does not include symbols for all types of electrical apparatus, but consists of a limited list which can be used in a number of combinations to show all kinds of electrical equipment. The ASA publication is a 40-page booklet, but one of the electrical manufacturers has condensed the ASA booklet into a one page blueprint which is very convenient. ASA standards may be obtained by writing the American Standards Association, 70 East Forty-Fifth Street, New York 17, New York.

NEMA

The National Electrical Manufacturers Association issued a number of new standards during the year. The NEMA standards are designed to eliminate misunderstandings between the manufacturer and the purchaser, and to assist the purchaser in selecting and obtaining without delay the proper product for its particular need These standards define a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing and the service for which designed.

NEMA standards are of three classes: a. Adopted standards which relate to products commercially standardized and subject to repetitive manufacture, and approved by at least 90 per cent of the members of the pertinent subdivision eligible to vote; b. Recommended standards which relate to products which may be commercially standardized and subject to repetitive manufacture, and approved by at least two-thirds of the eligible voting members of the pertinent subdivision; and c. Suggested standards for future designs which may not have been regularly applied to a commercial product, but which suggest a sound engineering approach to future development, and which standards have been approved by at least two-thirds of the eligible members of the pertinent subdivisions.

The existence of a NEMA standard does not in any respect preclude any member or non-member from making or selling products which do not conform to the standard.

"NEMA Standards for Industrial Control," publication number 45–97, was published in September 1945. This publication covers rating, performance, application and manufacturing standards for resistors, contactors, brakes and a-c and d-c controllers. It covers general purpose and machine tool control, graphic arts control, mine hoist control, magnetic control for steel mill auxiliaries, and magnetic control for cab operated and floor operated cranes. Other standards covered are synchronous motor control and high interrupting capacity controllers as follows: oil immersed 2200-4600 volts or less, air break 600 volts a-c and less, and air break 600 volts d-c and less.

Another important standard issued in January 1945 was "NEMA Power Switching Equipment Standards," publication number 45–94. This publication gives rating values, manufacturing standards and application standards for bus supports, air switches, interrupter switches and outdoor substations (including structural work therefor).

A new revision on motor and generator standards was issued in June 1945 called "NEMA Motor and Generator Standards," publication number 45–102. These standards provide practical information concerning construction, test, performance and manufacture of a-c and d-c electric motors and generators. The standards do not apply to heavy traction motors for railroads, motors for mining locomotives, arc-welding generators, toy motors and generators, nor to electric fans of the desk, bracket or ceiling types.

A complete set of new standards for electric arc-welding machines and electrodes was published in September 1945. It is called "NEMA Electric Arc-Welding Machine and Electrode Standards," publication number 45–105, and supersedes publication number 42–81. The latest revision of arc-welder standards incorporates the desirable changes resulting from wartime experience. The welding standards completely cover d-c welders of both variable voltage and constant potential types, including circuit control equipment for the latter. The standards also include two types of a-c, transformer-type arc welders, designated as the indus-

trial type single operator, and the limited-input type. The new standard rates both d-c and a-c welders on the basis of the same duty cycle, using the d-c welder as a base. The duty cycle is the ratio of the arc time to the total time, and for the rating purposes the time period of a complete test cycle is 10 minutes.

Welding electrode standards have also been revised and published in two parts. The part covering classifications, standard diameters, and package weights is included in publication 45–105. The new standard for color markings for electrode identification is published as a separate standard in publication number 45–108.

AIEE

The American Institute of Electrical Engineers issued a most valuable book during the year called "Electric Power Distribution for Industrial Plants." The book is not an AIEE standard, but is intended to promote the use of sound engineering principles in the design of electric power distribution systems for industrial plants and in the selection of equipment for these systems. The report was developed by the AIEE committee on industrial power applications.

For the purpose of the report, the distribution system is considered as extending from the point of entrance of the power company service or the plant generating bus to the terminals of the utilization devices. This includes high tension substations, distribution substations, feeders, circuits, switch centers, and protective equipment. The report gives considerable data on design, demand and diversity factors, power factor, effects of voltage variation, circuit arrangements, voltage regulation, fault current calculations, and wire and cables. The committee on this project has done a most excellent job, and one of great value to the industry.

The AIEE is supplementing the work on circuit breaker standards which was adopted this year as an ASA standard and which was previously described in this report under the ASA section. The AIEE Protective Devices Committee will soon issue Standard No. 20 on "Low Voltage Air Circuit Breakers." This standard will probably cover, in general, all air circuit breakers with interrupting ratings of 10,000 amperes and above, except for some special cases.

Another standardization project: "Standards for Mercury Arc Rectifiers" will also be presented to the AIEE for approval in the near future.

AMERICAN SOCIETY FOR TESTING MATERIALS

In October 1945, the ASTM issued a special compilation of more than seventy-five widely used specifications and test methods covering electrical insulating materials and related products. The book is valuable to the man writing specifications on electrical insulating materials.

ASSOCIATION OF IRON AND STEEL ENGINEERS

The standardization committee of the Association of Iron and Steel Engineers was quite active during 1945. In the September 1945 issue of the Iron and Steel Engineer, the "AISE Standard Design for Crane Shaft Couplings" was published. This standard reduces standard crane shaft couplings to four in number. The standard is tentative for a year, after which time necessary changes may be made as determined by the year's experience.

At the fall meeting of the Board of Directors of the AISE an extensive standardization program, which had been submitted by the standardization committee, was approved. Among the projects on which standardization work is being done are flexible couplings; size of safety switches (switches to be standardized on mounting dimensions for interchangeability between various manufacturers); size (length, width and breadth) and type of shunting for motor brushes; chains and slings; sleeve bearings; and wiring diagrams and control schemes. Some of these items have been standardized within individual companies with surprising results in economy, and standardization on an industry-wide basis would be still more effective. The committee is also working on standard procedures, handbooks, and several research projects.

The procedure used in AISE standardization work varies with the project but is handled roughly as follows. Each topic is assigned a member of the standardization committee who is then responsible for its execution. A subcommittee is then formed which studies the relative use of various types and sizes of the item involved. Such study will probably involve a survey of the manufacturers and users to obtain their data and suggestions. The results of the surveys are analyzed and a standard is selected. If research work is necessary in order to go further, a research program may then be carried out. The results then may or may not be returned to the industry and manufacturers for a final criticism, and a standard, tentative for one year, is then published. At the end of the year, if experience warrants any changes, these are made in the final standard as then adopted.

Such standards, of course, are of value only if they are used, and the more they are used, the greater are the benefits returned. There is no better example of standardization than that which was carried out several years ago by the AISE on standardization of mill motors, and which has resulted in broad savings to the industry. Similarly, the mill crane specifications which the AISE has revised in the past five years can save up to one-third the weight of the crane girders. The specifications will also afford a uniform basis on which one may evaluate bids.

The chairman of the AISE standardization committee is Frank Cramer, electrical engineer, Carnegie-Illinois Steel Corporation. Other members of the standardization committee for 1946 are: K. E. Dinius, chief engineer, South Works, Carnegie-Illinois Steel Corporation; Hugh B. Conover, maintenance engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania; Eric Anderson, superintendent, electrical department, Bethlehem Steel Company, Johnstown, Pennsylvania; A. J. Fisher, fuel engineer, Bethlehem Steel Company, Sparrows Point, Maryland; F. E. Kling, Youngstown, Ohio; H. W. Neblett, special engineer, Inland Steel Company, East Chicago, Indiana; Chas. E. Pritchard, lubrication engineer, Republic Steel Corporation, Cleveland, Ohio; J. B. Mitchell, superintendent rolling mills, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania; Robert W. Graham, electric superintendent, Bethlehem Steel Company, Lackawanna, New York; I. E. Madsen, standards engineer, Association of Iron and Steel Engineers; and T. J. Ess, managing director, Association of Iron and Steel Engineers.

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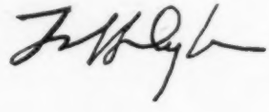
The President's Message

The iron and steel industry has completed nearly four years of wartime operation. It has hurdled every difficulty and obstacle put into its path, and its record speaks for itself. Such continuous effort has left much of its equipment worn out, and many of its men tired out.

Steel is, without doubt, our most useful and versatile metal. Its many uses are beyond count. The engineers, operators and specialists connected with its manufacture are many. The efforts of all must be utilized to the utmost to solve the many problems which lie ahead.

The Association of Iron and Steel Engineers pledges itself to do everything in its power to further the interchange of knowledge along engineering and technical lines which will be of greatest benefit to its members and the industry which they serve. To accomplish this it will need the assistance of each of its members, as well as that of the industry itself.

The continued full cooperation of all of us will do much to brighten the path back to peaceful living.



Freeman H. Dyke, *president*

1946

ASSOCIATION OF IRON AND STEEL ENGINEERS

FREEMAN H. DYKE graduated from Phillip Andover Academy and from the Massachusetts Institute of Technology. Mr. Dyke started in the steel business with the Wheeling Steel Corporation at their Portsmouth plant in 1920, and with the exception of three years with the Jones and Laughlin Steel Corporation he has been with Wheeling Steel Corporation continuously. After serving in several capacities in various departments, Mr. Dyke became superintendent of the blooming, bar and hot strip mills at the Steubenville plant, and was subsequently made assistant general manager in charge of steel works.

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First Vice President

A. J. FISHER
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C. H. WILLIAMS
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Officers and Directors

1946

L. R. MILBURN was graduated from the University of Michigan with a degree of electrical engineering in June, 1918. From July, 1918, until 1919 he went with the General Electric Company doing testing, complaint, installation, and apparatus sales work. In March 1925, he moved to the Louisville Gas and Electric Company where he did construction work until October, 1929, obtaining excellent knowledge of the workings of the central station industry. Starting his steel mill career in October, 1929, with the Great Lakes Steel Corporation as electrical draftsman, Mr. Milburn remained in this position until 1933 when he was appointed acting electrical engineer. In 1935 he was promoted to electrical engineer.

A. J. FISHER was graduated from the Colorado State preparatory school and later from the University of Colorado, college of engineering, with a degree in mechanical engineering. Mr. Fisher began his steel mill employment with the Bethlehem Steel Company at the Maryland plant as assistant master mechanic of the sheet and tin mill division in 1924. After serving in several capacities in various departments, Mr. Fisher became fuel engineer in 1929, holding that position at the present time.

C. H. WILLIAMS was graduated from the University of Colorado in 1926 and was employed by Jones and Laughlin Steel Corporation as shear foreman in their Pittsburgh plant. In 1927 he became a junior engineer in the power department of National Tube Company at Pittsburgh, shifting in 1930 to the Ohio Works of Carnegie Steel Company. Here he served successively as junior engineer, power and fuel engineer, and assistant chief engineer. In 1940 Mr. Williams was transferred to the Pittsburgh office of Carnegie-Illinois Steel Corporation as power and fuel engineer on the staff of the chief engineer, and was subsequently appointed assistant chief engineer of the Pittsburgh district. In 1941 he was placed in charge of a newly organized defense engineering staff to coordinate the engineering of defense steel plant expansions of the company in the Pittsburgh district. He was subsequently transferred to the United States Steel Corporation of Delaware as assistant to the vice-president of engineering, and in 1943 to chief engineer of the Pittsburgh district, Carnegie-Illinois Steel Corporation.

ALBERT S. GLOSSBRENNER attended the University of Wisconsin and later entered the employ of the old Illinois Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation, at the Gary, Indiana tin plate plant. He then transferred to the same company's South Works at Chicago as assistant foreman. Five years later he joined Youngstown Sheet and Tube Company at Youngstown, Ohio, as assistant superintendent of the hot strip mill, becoming superintendent about three years later. He was appointed superintendent of the Brier Hill plant in September, 1942, and in 1943 was named general superintendent of the Youngstown district of The Youngstown Sheet and Tube Company.

JOHN F. BLACK received his elementary schooling in the Enid, Oklahoma, city schools, and attended the United States Naval Academy, class of 1926. He started in the steel business as pipefitter helper at Bethlehem Steel Company's Sparrows Point plant, progressing to steel shipper, labor foreman, gashouse foreman, general foreman of gas producers, combustion engineer, and general foreman of pipe mills. In 1941 he transferred to Atlas Steels Limited, Welland, Ontario, as fuel engineer and in 1943 was made assistant works manager.

LOUIS MOSES
Director

R. E. BOBBITT
Director

T. R. MOXLEY
Director

P. F. KINYOUN
Director

A. S. GLOSSBRENNER
Secretary

J. F. BLACK
Director-at-Large

VICTOR E. SCHLOSSBERG
Director

HAROLD E. PHELPS
Director

VICTOR E. SCHLOSSBERG started with the Inland Steel Company in 1926 upon graduation from Rose Polytechnic Institute. He assumed his present duties as assistant superintendent of electric and power departments in December, 1930. In 1945 he spent several months in Germany as a member of the technical group which was sent there to investigate the German steel industry.

HAROLD E. PHELPS has worked with electric furnaces since 1917. His early experience was with the Steel and Tube Division of Timken Roller Bearing Company, Canton, Ohio. He then transferred to Rotary Electric Steel Company at Detroit, Michigan, and has served as superintendent of electric furnaces there since 1933. He is a past president of the Electric Metal Makers Guild.

LOUIS MOSES started work with the Cambria Steel Company at Johnstown, Pennsylvania, as office boy and successively progressed as apprentice, machinist and mechanical draftsman on mill and machinery construction, maintenance, etc. He then entered the field of roll designing, where his experience embraced large and small rolling mills, extending later to the development of the varied rolling and manufacturing facilities of the expanding Sparrows Point plant of Bethlehem Steel Company, and to the supervision of operations of the rail mill at that plant.

R. E. BOBBITT was graduated in electrical engineering from Georgia School of Technology in 1918. He then entered the engineering department of Magnolia Petroleum Company, Beaumont, Texas, and soon moved to the engineering department of Atlantic Steel Company, Atlanta, Georgia. In 1920 he joined the Armour Fertilizer Works in Atlanta, returning to Atlantic Steel in 1922. Transferred to the mechanical department in 1923, he was made general master mechanic in 1939, in charge of mechanical, electrical and steam engineering departments, and in 1945 was advanced to chief engineer.

T. R. MOXLEY started as an apprentice in the shops of the Tennessee Coal, Iron and Railroad Company in 1903 and worked in the mechanical and engineering departments until 1921, when he became master mechanic of Woodward Iron Company's coke plant. In 1924 he returned to the Tennessee Company as assistant master mechanic of sheet mills, and in 1927 moved to Wheeling Steel Corporation as coke plant master mechanic. He was subsequently made assistant general master mechanic and in 1934 was appointed general master mechanic.

P. F. KINYOUN was graduated from Bucknell University in mechanical engineering. He started his employment with the Bethlehem Steel Company immediately after graduating, and in 1925 joined the combustion department at Bethlehem's Lackawanna Plant. In 1929 he was made assistant combustion engineer, and in 1931 was promoted to combustion engineer, the position he now holds.

W. T. ADAMS, after graduation from Hiram College, joined the Ohio Power Company in 1919 in test and construction work. In 1920 he moved to the Berger Manufacturing Company at Canton, Ohio, where he worked in various departments until that company became a part of United Alloy Steel Corporation. After four years in the claim department of the latter company, Mr. Adams joined the Moock Electric Company as sales manager. In 1933 he joined the purchasing department of Republic Steel Corporation, was subsequently put in charge of all electrical purchases, and in 1945 was made general purchasing agent.

T. J. McLOUGHLIN graduated from the Stevens Institute of Technology in mechanical engineering in 1913, and in the same year began a continuous service with the United States Steel Corporation, starting as an engineer-apprentice at the Duquesne Works of Carnegie Steel Company. In 1924 he became fuel engineer at Duquesne Works. Early in 1936, Mr. McLoughlin was appointed assistant to the manager of operations for the Pittsburgh district of Carnegie-Illinois Steel Corporation and later the same year was appointed assistant to the vice president in charge of operations, the position which he now holds.

I. N. TULL was born in Anniston, Alabama, reared in North Carolina, and graduated from North Carolina State College in electrical engineering in 1910. After a brief period of telephone work, he entered General Electric Company's test course at Schenectady. He was transferred to their Cleveland office's engineering department in 1912, remaining there until 1915, when he was employed by Corrigan, McKinney and Company as electrical engineer. The next 12 years were spent in engineering and construction work as that company built blast furnaces and a steel plant at Cleveland, Ohio and proceeded with extensive electrification of their iron mines and the opening of coal mines. In 1927, general supervision of electrical maintenance and operations was added to the construction duties. After the merger with Republic Steel Corporation in 1935, Mr. Tull became electrical superintendent of the Cleveland District for Republic.

GEORGE E. REISER graduated from Buffalo Technical High School in 1926 and ventured into the radio repair business. In 1934 he was employed by Bethlehem Steel Company in the electrical department, where he spent five years. He was selected in 1939 to become assistant to C. C. Pecu, lubrication engineer. After serving six years in this capacity, Mr. Reiser was advanced to lubrication engineer upon the death of Mr. Pecu.

W. T. ADAMS
Director

T. J. McLOUGHLIN
Director

I. N. TULL
Director

GEORGE E. REISER
Director

National Committees for 1946

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman, Freeman H. Dyke

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1937 H. G. R. BENNETT, *Engineer*, Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

1938 L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

1939 C. CLARKE WALES, Engineering Department, National Tube Company, Pittsburgh, Pennsylvania.

1940 J. A. CLAUSS, *Vice President in Charge of Engineering*, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

1941 W. A. PERRY, *Superintendent*, Electrical and Power Departments, Inland Steel Company, East Chicago, Indiana.

1943 F. E. FLYNN, *District Manager*, Republic Steel Corporation, Warren, Ohio.

1944 CHAS. L. McGRANAHAN, *Assistant General Superintendent*, Jones and Laughlin Steel Corporation, Pittsburgh Works, Pittsburgh, Pennsylvania.

1945 J. L. MILLER, *Assistant Chief Combustion Engineer*, Republic Steel Corporation, Cleveland, Ohio.

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E. L. ANDERSON, *Superintendent Electrical Department*, Bethlehem Steel Company, Johnstown, Pennsylvania.

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NO TIME OUTS

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Where heat is a problem, investigate G-E Deltabeston Asbestos-insulated Cables. They save many hours of maintenance time in steel mills, mines and power plants where scorching heat ruins ordinary cables. General Electric manufactures a complete line of asbestos insulated cables including many special designs.

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Give Trouble-Free Service

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GENERAL ELECTRIC

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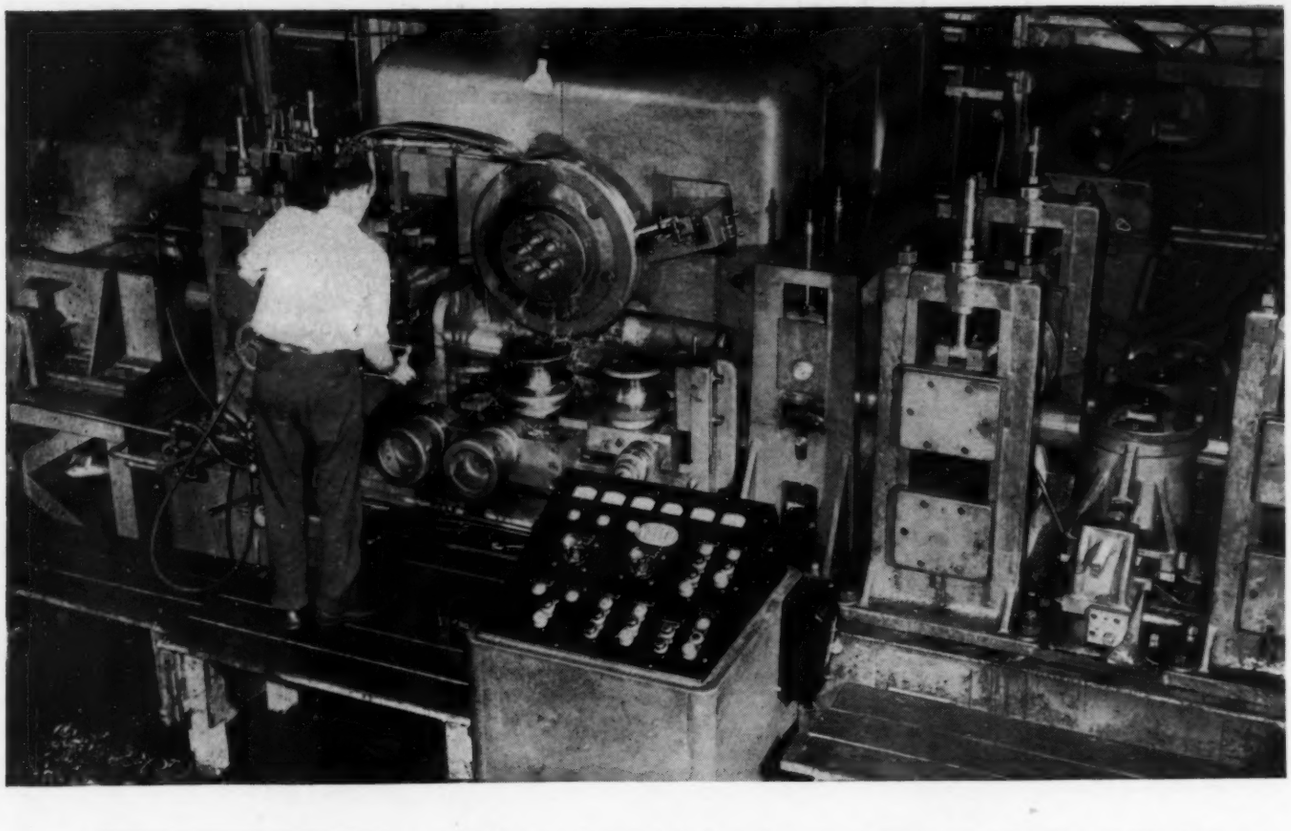
MIDVALE

Custom Steel Makers to Industry

PRODUCTION . . . In Miles Per Day!



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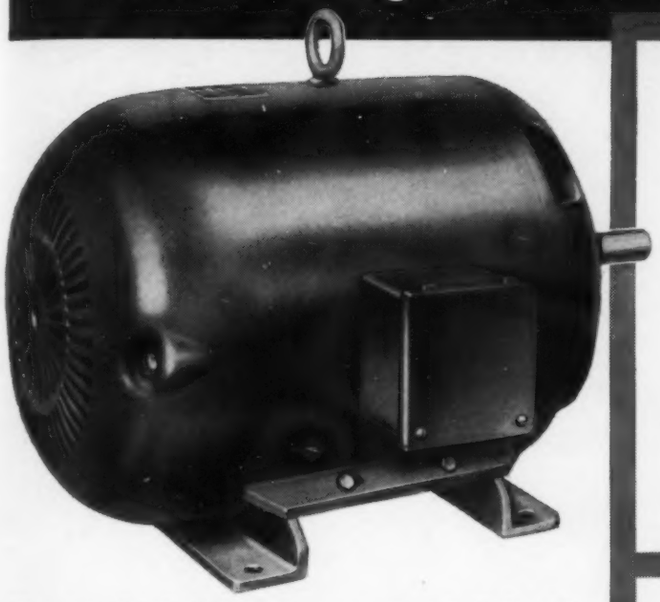
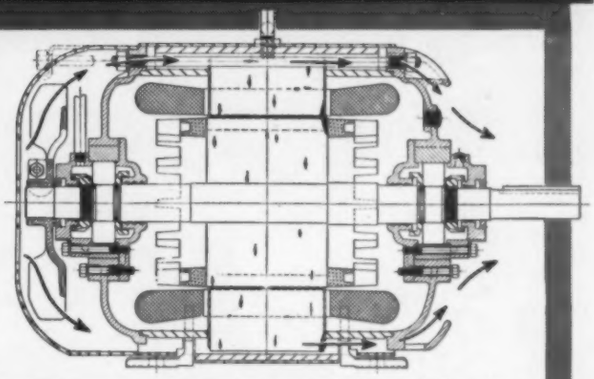
Maintenance Costs Go Down and Costly Shutdowns Are Avoided When This Wagner Two-Frame Motor is Put on the Job



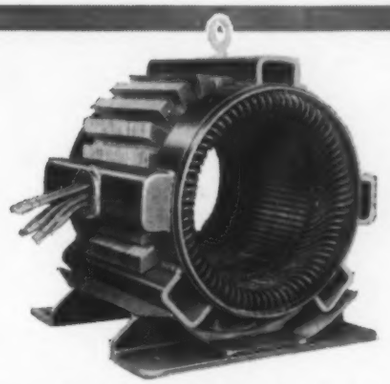


The Wagner type CP totally-enclosed fan-cooled motor has two frames: an outer frame that guides a strong cooling draft over the motor, and an inner frame completely sealed against the entrance of dust, fumes, or moisture into the vital parts of the motor.

The cost of maintaining open-type motors is likely to be excessive when dust, fumes, or moisture are present. Abrasive, conductive, or explosive dust, corrosive gases or fumes, steam and moisture are destructive to motors and cause frequent motor shutdowns for cleaning and repairing. The way to avoid excessive motor maintenance and production losses during motor shutdowns is to use Wagner type CP totally-enclosed fan-cooled motors which are fully protected against such destructive agencies.

As the upper diagram shows, Wagner type CP motors are self-protected against the entrance of dust, fumes, and moisture, and therefore give uninterrupted service despite severe operating conditions. Experience has proved time after time that motor protection costs less than motor maintenance, that maintenance costs go down, production goes up, and motor worries end when you standardize on Wagner CP motors throughout your plant.

Wagner type CP motors are available in several electrical types, and are but one of a widely diversified line of Wagner motors, all fully described in Bulletin MU-185 free upon request addressed to Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.



The heart of the Wagner CP motor is this rugged, all-steel stator, rigidly constructed to meet the exacting needs of modern high-speed production. In larger sizes, the outer surface is deeply grooved (as here shown) to provide ample cooling surface for cool operation. The winding is completely taped well into the slots and all phase coils are insulated from each other by varnished-muslin phase-sheets.

M46-3

Consult Wagner Engineers on all Electric Motor Problems

Electric Motors • Air Brakes • Brake Lining Hydraulic Brakes

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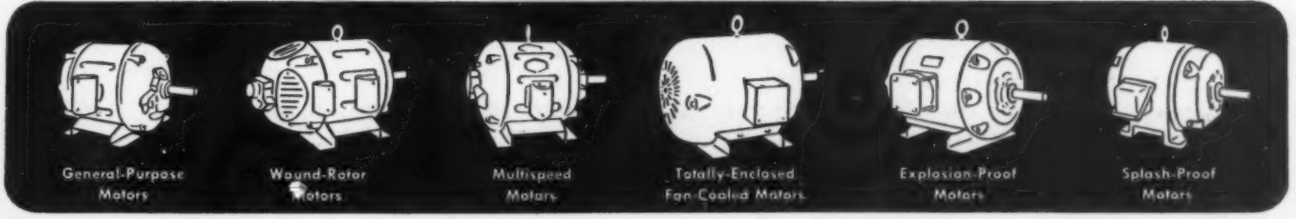
Transformers • Industrial Braking Systems NoRoL • Tachograph



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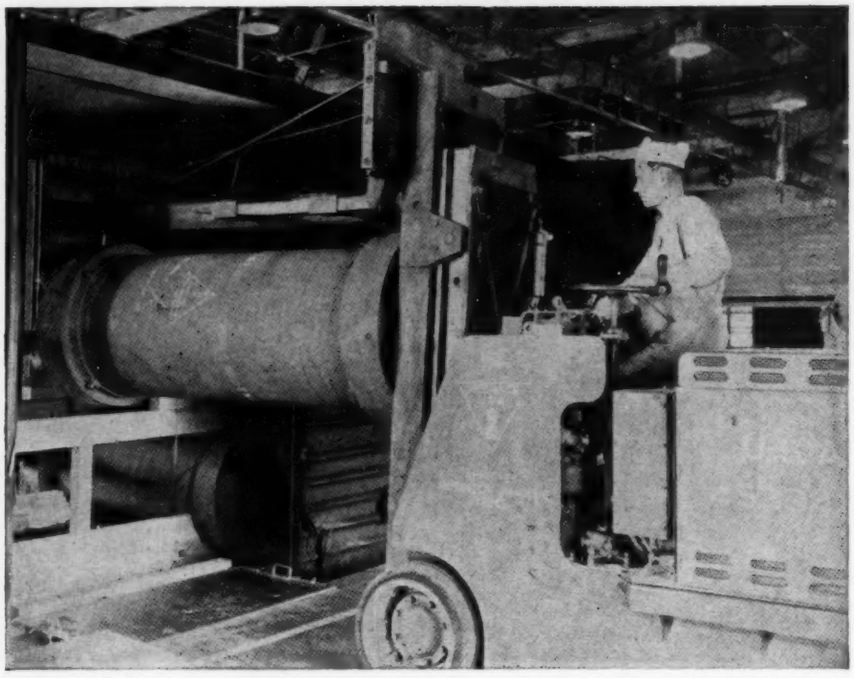
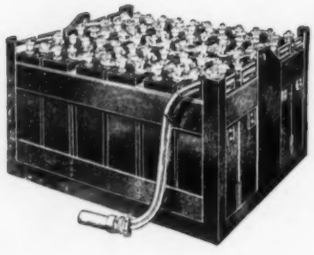
Use Battery Trucks for SAFE handling





...Alkaline Batteries for Most Dependable Power

One of the outstanding advantages of battery industrial trucks for material handling is their inherent safety. Because they give off no fumes and are practically free from fire hazards, they can be used without restriction in almost any kind of plant. They can even be provided with spark-enclosed construction for safe operation in hazardous locations. Many are operating successfully in ordnance depots.

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Thus the battery truck is an inherently dependable, safe and economical handling unit, especially when powered by Edison Alkaline Batteries. With steel cell construction, a solution that is a natural preservative of steel and a fool-proof principle of operation, they are the most durable, longest-lived and most trouble-free of all batteries. Edison Storage Battery Division of Thomas A. Edison, Incorporated, West Orange, N. J. In Canada: International Equipment Company, Limited, Montreal and Toronto.

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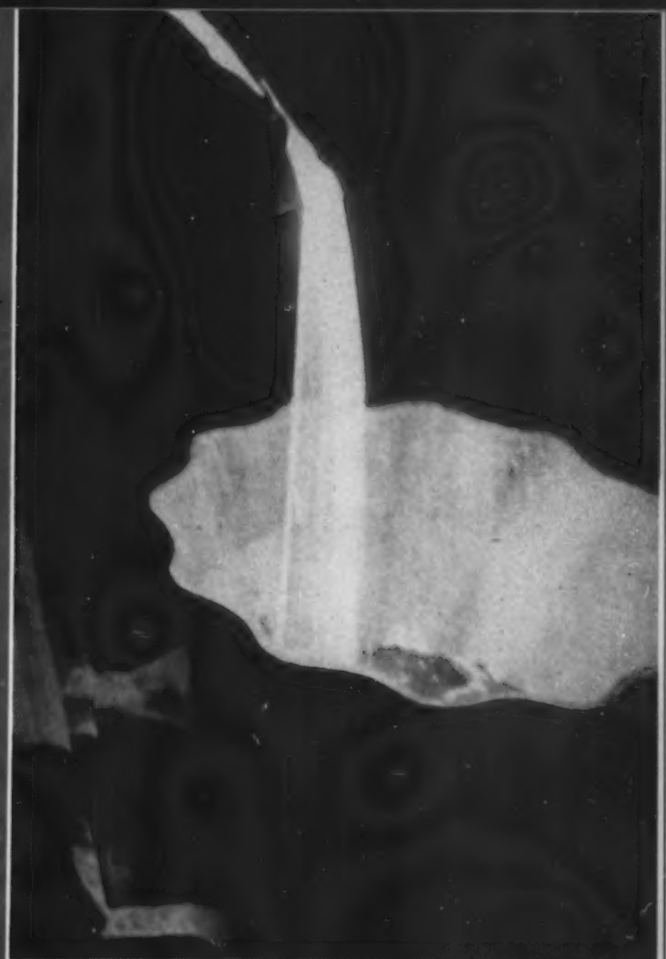
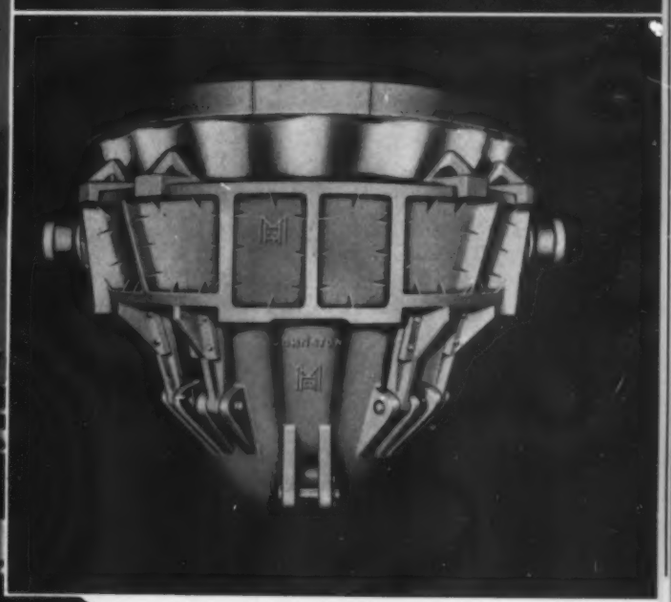
1803

Mackintosh-Hemphill Company is the exclusive licensee for the manufacture and sale of Johnston Patented Corrugated Pots and Supports.





MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Wapakoneta SHEAR BLADES and SLITTERS ...

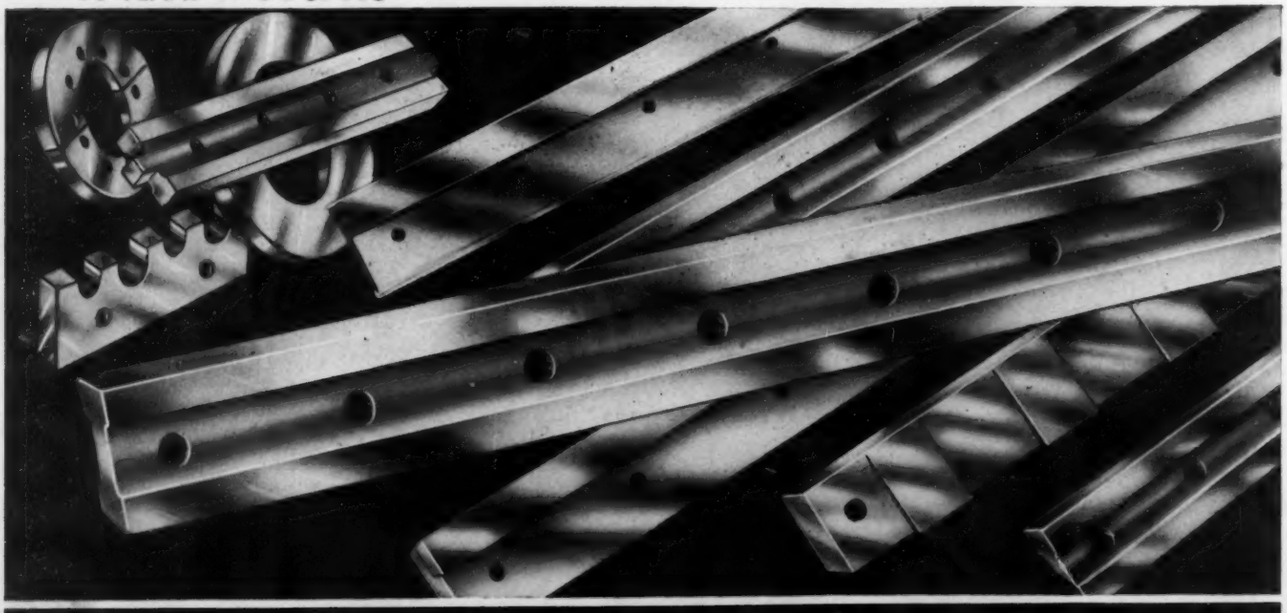
ENGINEERED FOR THE JOB

MORE THAN 50 YEARS of Service

THEY HOLD THE EDGE

because they are tempered and ground for your particular needs

Wapakoneta Shear Blades are made and heat treated, ***not*** to meet some universal standard of our own, but to best fill each customer's requirements... That is why Wapakoneta Shear Blades stand up longer on the job and cut more tonnage.



The Wapakoneta Machine Company

INCORPORATED 1891 — Wapakoneta, Ohio U.S.A.

Illustration from Dolph advertisement appearing in The 1916 Electrical Railway Journal

Serving Industry for 35 Years

1910 **Dolph's** 1945

INSULATING VARNISHES

This is a record of which we are justifiably proud. During our "span of life", we have put forth our every effort to serve the electrical industry faithfully and efficiently in the capacity of insulating varnish specialists.

There has never been, and never will be an insulating problem too difficult for us to do our utmost to solve; or an account or prospective account too "small" for us to service. This policy in itself has brought to us thousands of friends and satisfied users of DOLPH'S Products.

We pledge our continuance of this policy, and with our years of experience and research in the insulating varnish field, we feel fully confident that we can assist you in your own particular insulating problems. Write us; we welcome the opportunity to serve you.

JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

1060 BROAD STREET, NEWARK 2, N. J.

ENGINEERS AND BUILDERS OF

Rolling Mill Machinery

Subsidiary Company

TAYLOR-WILSON MFG. CO.
McKEES ROCKS, PA.

Products:

SEAMLESS TUBE MILLS
BUTT-WELD PIPE MILLS
TUBE CUTTING-OFF MACHINES
HYDRAULIC TUBE TESTING EQUIPMENT
STRAIGHTENING, BURNISHING AND SIZING MACHINES
PIPE FINISHING MACHINERY
GALVANIZING EQUIPMENT FOR PIPE

PRODUCTS:

● STRIP PROCESSING EQUIPMENT

SLITTERS AND SIDE TRIMMERS
REELS — TAKE-UP AND PAY-OFF
LEVELLERS AND SCALE BREAKERS
HYDRAULIC COIL LIFTERS AND TRANSFERS
COIL BOXES AND HANDLING EQUIPMENT
SHEARS — UP-CUT AND DOWN-CUT TYPES
PINCH ROLL AND PULL-OUT STANDS
SCRUBBERS — STRIP AND SHEET
ROLLING MILLS — NARROW STRIP AND WIRE FLATTENING
SCRAP HANDLING AND BUNDLING EQUIPMENT

● HOT MILL AUXILIARY EQUIPMENT

TRANSFERS
COOLING BEDS
COBBLE COILERS
ROLLER TABLES
HOT BEDS
PILERS
CRADLES — STATIONARY AND SCALE TYPE

● WIRE PROCESSING EQUIPMENT

PATENTING FRAMES
ROD COILERS
SCALE BREAKERS
SCRAP BALLERS
BUNDLING AND TESTING BENCHES

● PICKLING EQUIPMENT

GREER CONTINUOUS COIL TYPE
SPECIAL STRAND TYPE
BATCH PICKLES

THE ARMS-FRANKLIN CORPORATION

YOUNGSTOWN 3, OHIO

NEWS SUPPLEMENT January, 1946

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TRUSCON STEEL COMPANY PLANT WINS DISTINGUISHED SERVICE TO SAFETY AWARD

▲ The Truscon Steel Company plant at Youngstown, Ohio, a subsidiary of Republic Steel Corporation, has won the National Safety Council's Distinguished Service to Safety Award according to word received by Peter Robertson, works manager.

The citation was instituted during the war in a campaign to save "manpower for warpower." To be eligible for the award it is necessary that a plant show a reduction of 10 per cent or more in its accident frequency and severity rate over the previous year and that it maintain a lost time accident record of 50 per cent or more below the average for the industry.

The Truscon award was based on the achievement of over 4 million manhours without a lost time accident between February 22 and November 13. The plant, however, since November 13 has continuously added on to this safety record. This has been accomplished in the face of reconversion activity at the plant with the hazards adjacent to moving heavy machinery.

The award is a special award and is in addition to the regular National Safety Council's annual competition. Truscon won second place in its division in this contest last year and is this year leading its division (Group A — rolling, finishing and fabricating division).

The award comes as the result of a concentrated safety campaign at Truscon where war work virtually tripled its work forces and a wide variety of war products much different than the normal peacetime goods of the plant was turned out. During the war Truscon made army tank treads, navy aircraft fuselages, landing barges, fabricated sections of large ocean going vessels, airplane steel landing mats and other products.

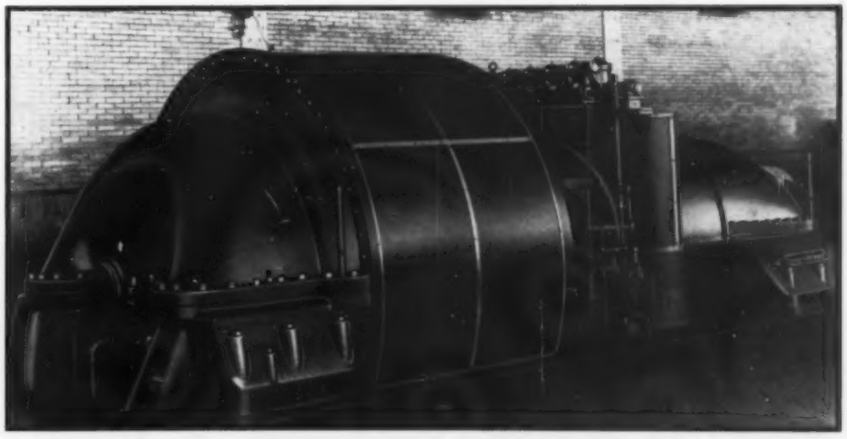
The work force jumped from about 1,700 to over 5,000 and many of the wartime employees were women who had no previous industrial experience and had to be hastily trained in skilled jobs.

COMBUSTION EQUIPMENT BURNS BOTH OIL AND GAS

▲ Perhaps the most serious problem that many steel mills have had to face in recent years has been the matter of fuel shortages. Realizing that it is often necessary for a plant to switch from fuel gas to fuel oil in a matter of minutes, the North American Manufacturing Company of Cleveland, Ohio, has developed two separate lines of burners that will burn efficiently either fuel oil, as heavy as a bunker C, or any fuel gas of 500 Btu or higher. A goodly number of steel plants have installed this type of equipment on their furnaces, which has enabled them to maintain continuous operation during the periods of fuel shortages. The North American system is unique in that the fuel to air ratio is automatically controlled by making the pressures of the mediums interdependent. This system, then, allows the main control valve that governs the amount of fire to be placed in the air line supplying a battery of burners. The same control valve is used whether gas or oil is being burned.

Another feature of the system which is popular with many mills is that no compressed air or steam is required for atomization of the fuel oil. A turbo blower supplied by the manufacturer at approximately one psi pressure is sufficient to provide the atomization of the fuel oil. This blower is also often used to supply the air for combustion when on either gas or oil.

WORLD'S LARGEST BLOWER DEMONSTRATED



The 125,000 cfm, 30 psi, 14,500 hp turbo-blower above set the theme around which the Ingersoll-Rand Company built two two-day conferences on turbo-blowers at its Phillipsburg, New Jersey plant on December 10-14. More than 75 steel mill officials and engineers attended each session, the purpose of which was to study the latest developments in turbo-blower design and to discuss the many problems involved in applying turbo-blowers to various steel mill operations. C. B. Kidney, chief engineer of the turbo-blower division, gave a detailed paper on the development of the turbo-blower from its inception to the present. The talk was followed by a tour through the plant where a 125,000 cfm blower was undergoing test, and other blowers in all stages of construction and in all size ranges were available for inspection.

Can't Knock Out Permanently Insulated ROCKBESTOS A.V.C.

You may not be looking for trouble . . . but it's on its way if you are still operating overworked circuits that were nearing collapse before the war . . . and if you still have war-installed control, power and lighting wiring in hot spots that wasn't built to take the beating of high ambient temperatures and conductor-heating overloads.

Why take chances if that's your situation? Check up on the trouble-spots and plan to eliminate future production tie-ups, shut downs, and expensive emergency maintenance by re-wiring with Rockbestos A.V.C. Power Cable, Motor Lead Cable, Control Cable and Boiler Room Wire. Their *impregnated asbestos* insulation and heavy *asbestos* braid takes operating temperatures up to 230° F., the heat of overloads, and vibration because it retains flexibility and won't bake brittle or crack. It won't bloom or rot when exposed to oil, grease or corrosive fumes . . . it won't burn because asbestos is fireproof . . . and it can be installed in conduit because specially compounded impregnants give it high moisture resistance.

Don't delay necessary wire-failure prevention . . . investigate your needs for the Rockbestos-designed National Electrical Code types illustrated and others in our line of 125 different standard wires, cables and cords. Write or phone for recommendations to the nearest district office or:

ROCKBESTOS PRODUCTS CORPORATION
117 Nicoll St., New Haven 4, Conn.

125 different wires, cables and cords developed for severe operating conditions by Rockbestos.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK BUFFALO CLEVELAND CHICAGO PITTSBURGH ST. LOUIS
LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

INVEST IN U. S. VICTORY BONDS

FOR POWER CIRCUITS

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE (Nat. Elec. Code, Type AVA—max. operating temp. 110°C.)

Sizes No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated felted asbestos, varnished cambric and asbestos braid. Other constructions for service voltages to 5000.

You can use Rockbestos A.V.C. Power Cable for hot-spot wiring, in conduit or open, around boiler rooms, steam lines, furnaces, etc., and for power leads or heat-exposed electrical equipment as it withstands high temperatures and has ample moisture resistance. Use similarly insulated Rockbestos A.V.C. Motor Lead Cable for motor leads and coil connections.

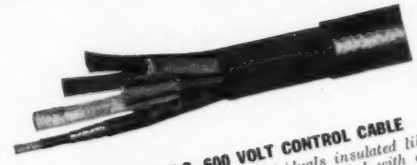
FOR LIGHTING CIRCUITS

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE (Nat. Elec. Code, Type AVA—max. operating temp. 110°C.)

Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of impregnated asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal. Its permanent insulation will not bake brittle, crack, rot, flow or swell.

FOR CONTROL CIRCUITS



ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors with individuals insulated like Power Cable, cotton braid covered, and cabled with an asbestos braid overall. Standard strandings AWG No. 12—19/#25 and No. 9—19/#22. Other strandings on order.

Designed for use in equipment requiring a multi-conductor control cable capable of withstanding high temperatures, this cable is widely used in the control systems of electric cranes and other equipment used in steel mills. The insulation is unaffected by heat, corrosive fumes, oil or grease and has ample moisture resistance.

ANOTHER NEW ROCKBESTOS HIGH TEMPERATURE CONSTRUCTION!

War-developed Rockbestos High-Temperature Wire — *with a maximum operating temperature of 400° F.* — designed for jet propelled plane applications and circuits to hot-wing de-icers, fire detectors and extinguishers, and air conditioning and heating units where baking temperatures destroy ordinary insulation. Under continuous operation at rated temperature it retains its original dielectric strength and inherent resistance to heat and flame, and *progressively improves* in its resistance to moisture and abrasion. It is now available for these and other severe applications. Write for complete information and samples.

SILICONE PRODUCTS, NOW PERMIT HIGHER MOTOR OPERATING TEMPERATURES

▲ The progressive development of various silicone products has substantially increased permissible operating temperatures in a wide variety of industrial processes and equipment. The development of silicone insulation, for example, has increased the permissible operating temperature of electrical equipment to 175 C and above. Motors operating at such elevated temperatures require bearing lubricants having greater heat stability than the conventional petroleum greases possess. At the same time, high altitude flying and arctic operations have necessitated the development of lubricants serviceable at very low temperatures.

To supply the need for high and low temperature lubrication, Dow Corning Corporation has developed four silicone greases which are now available. These new silicone greases designed for the lubrication of ball bearings operating at abnormally high and low temperatures are characterized by a high order of heat stability, low volatility, relatively slight changes in consistency over a wide temperature range, and low freezing points.

Two of these greases, DC 31 and DC 41, are compounded of almost entirely inorganic materials. They are black in color due to the use of very finely divided carbon black as a thickening agent. They contain no graphite. Although they possess exceptional thermal stability, they do show a slight tendency to bleed during storage. Tests indicate, however, that this superficial bleeding does not impair the performance of these greases. DC 31 and DC 41 are corona resistant and are semi-conducting because of their carbon black content. The electrical conductivity of these two greases is in the order of 1,000 ohm centimeters.

The other two greases, DC 33 and DC 44, are light brown in color. They are compounded with metallic soaps selected for their heat stability. DC 33 and DC 44 are serviceable at temperatures as high as the melting points of the metallic soaps. They show very little tendency to bleed. These two soap type silicone greases have just recently become available and a considerable amount of developmental work is still being done on them.

Of the four silicone greases, DC 31 and DC 33 are designed primarily for low temperature lubrication, but they also operate efficiently at elevated temperatures. DC 41 and DC 44 are designed for high temperature lubrication.

It is recommended that old organic grease be removed and bearings cleaned before relubricating with the more heat stable silicone greases. However, if bearings are not accessible, the silicone greases can be added without damage since there is a limited compatibility between them and most petroleum greases.

A high order of temperature stability, resistance to water and general inertness suggest the use of silicone greases for permanently lubricated bearings, for lubricating ball bearings operating at high and low temperatures, for the lubrication of oven machinery, pumps handling hot salts, and for low speed equipment operating at temperatures up to 480-500 F.

Even though these greases are perfectly stable at elevated temperatures, there is still the problem of bearing design and construction to be considered. In some instances it will be found advisable to use bearings with larger clearances to compensate for temperature differential in the bearings. Preliminary tests have shown that the use of bronze ball cages materially lengthens the life of bearings at elevated temperatures. The development of silicone greases for journal bearings and extreme pressure lubrication is still in the laboratory stage.

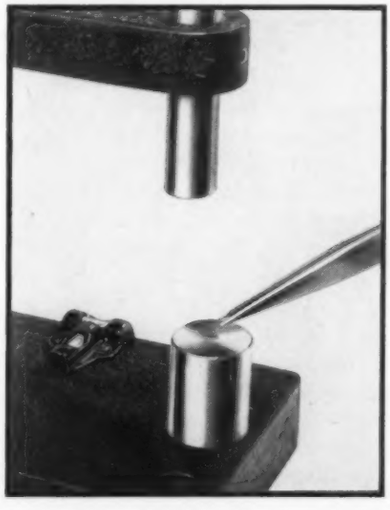
It may be observed in general that there are very few established test procedures for determining the relative serviceability of various greases.

MAGNETIC TESTER GAGES HARDNESS OF SMALL FERROUS METAL PARTS

▲ A new magnetic hardness tester for rapid, accurate gaging of hardness of small ferrous metal parts has been announced by General Electric's meter and instrument division, West Lynn, Massachusetts. Providing a convenient "go — no go" hardness gage, this tester simplifies inspection of such parts as electric-instrument pivots and shafts, watch shafts, small steel balls, and other parts too small to be production-tested with mechanical-type hardness testers. It also permits spot checking of hardness in large sheets, or lengths of steel wire, through the comparison of random-selected small samples.

The tester, 6 in. long, 3½ in. wide, and 7 in. high, consists of an alnico bar magnet set in an adjustable, soft-iron frame, which permits the air gap, and thereby the field strength, to be set at the correct value for testing pieces of different size, whose dimensions are between 1/16 and ½ inch. A knurled thumscrew locks the air gap adjustment, and a brass block for positioning the specimens is mounted on the base of the tester, a little out of the direct line of the magnetic field. A two-way level is attached to the base to show when the tester is properly positioned, and a pair of brass tweezers is furnished for handling the specimens.

The operation of the magnetic hardness tester is based upon the correlation of hardness and coercive force in magnetic materials. It checks pieces of unknown hardness against a specimen of known hardness by comparing, in a simple, mechanical test,



This hardness tester will distinguish as little as two points on the Rockwell "C" scale.

the relative strength of the magnetism produced in the test pieces and in the standard specimen, under the same conditions of magnetization. This test will distinguish differences as little as two points on the Rockwell "C" scale, and does not damage the piece tested.

Many of the standard tests are in themselve inconclusive and the final proof of the quality of any grease is its performance under specific conditions. The Dow Corning Silicone greases have been tested under actual service condition. Their performance justifies the recommendation that in ball bearings causing repeated difficulty or requiring excessively frequent lubrication that silicone grease designed for such service be tried. Test samples will be sent upon receipt of a statement of the lubrication problem involved.

DC 31 is an almost completely inorganic grease and was designed for low temperature lubrication at operating speeds of less than 4,000 rpm. It is serviceable at temperatures as low as —95 F and yet has about the same lubricating life as the best grades of high temperature petroleum grease at temperatures of 200 to 300 F. Prolonged operation at elevated temperatures does not appreciably affect the low temperature starting torque of DC 31.

Even at temperatures up to 480 F. this grease does not melt, but it is not recommended for use at temperatures above 300 F. Tested in the No. 308 bearings of a 7½ hp motor operating under belt load at 1,750 rpm, this grease had a service life of 460 hours at 284 F.

DC 31 is completely water-resistant under any service conditions. It is resistant to the oxidation of air or ozone.

DC 33, a silicone grease thickened with metallic soaps, was designed for the low temperature lubrication of bearings operating at speeds up to 10,000 rpm. It is serviceable over a temperature range of —95 F to 300 F. The testing of this grease in a No. 212 ball bearing operating under no load at 1,725 rpm is still in progress after 1,300 hours at 150 C with no apparent deterioration in serviceability. The water resistance of DC 33 is comparable to that of calcium or lithium based petroleum greases.

Dow Corning silicone grease No. 41 was designed for the lubrication of bearings operating at elevated temperatures and at speeds of less than 4,000 rpm. Because it is an almost completely inorganic grease, DC 41 does not melt at temperatures in excess of 480 F, but more frequent lubrication is required because of increased bleeding at temperatures above 300 F. Its extreme heat resistance recommends it for special applications such as the lubrication of pumps handling molten salts and oven machinery of all kinds.

DC 41 is serviceable at temperatures as low as —4 F. In the temperature range of 200 to 300 F, DC 41 has between 5 and 10 times the lubricating life of high quality petroleum greases designed for use at elevated temperatures. Tested in No. 212 bearings operating under a load of 150 lbs at a speed of 1,750 rpm, this grease was still serviceable after 2,600 hours of operation at 257 F. In the same testing equipment, DC 41 had a service life of 900 hours at 347 F.

DC 41 is completely waterproof under any service conditions. It is resistant to the oxidation of air or ozone.

DC 44 silicone lubricant is thickened with metallic soaps and is designed for the high temperature lubrication of bearings operating at speeds up to 10,000 rpm. It is serviceable at temperatures as low as —4 F.

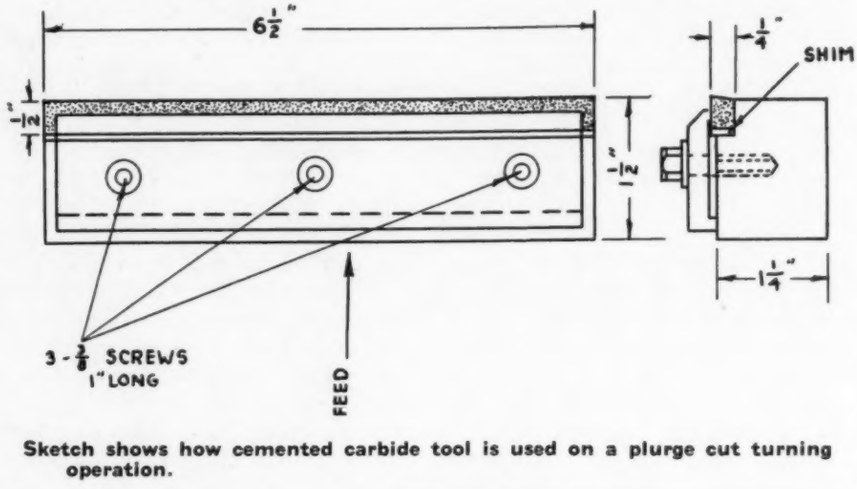
DC 44 is being tested in a number of different bearings operating at various speeds and temperatures. In a No. 204 bearing at a speed of 10,000 rpm, DC 44 is still serviceable after 700 hours at 302 F. It is still serviceable after 1,300 hours in a No. 212 bearing operating under no load at 302 F and 1,725 rpm.

The water resistance of DC 44 is comparable to that of calcium of lithium based petroleum greases.

CARBIDE TOOL TAKES SEVERE IMPACT

▲ Reconditioning extremely hard chilled iron rolling mill rolls has been materially simplified and speeded up in one shop by the use of a Carboloy cemented carbide tool on a plunge cut turning operation.

The chilled iron roll to be reconditioned was approximately 20½ in. by 53 in. The refacing tool, as can be seen from the accompanying sketch, was mounted on the bed in the conventional manner by use of a yoke and wedge. The tip of the refacing tool was formed of Carboloy cemented carbide.



Sketch shows how cemented carbide tool is used on a plurge cut turning operation.

During the turning operation, the roll turning lathe was run at its maximum speed, giving a cutting speed of 15 fpm. The tool was fed into the cut by means of a wedge. This wedge fed the tool into the work each time it was advanced by striking the wedge with a hammer. While this method of feeding is scarcely ideal, no tip breakage was experienced and the tool life was eventually found to be 10 times longer than that of the conventional chill tool which had formerly been used.

As the carbide tip was reground, a shim was placed behind the tip (see sketch) so that the shank would not have to be reground.

ASKANIA OPENS PITTSBURGH FACTORY BRANCH OFFICE

▲ A factory branch office to handle Askania engineering, sales and service in the Pittsburgh district has been opened in the Bessemer building, Pittsburgh, Pennsylvania.

The office will be under the management of Mr. E. R. Engstrom who has been with the home office of Askania Regulator Company since the beginning of the company. C. E. Hague, who was in charge of Askania sales in Cleveland, is now sales manager of the Pittsburgh and Cleveland districts.

AMERICAN STEEL AND WIRE TO MODERNIZE AT WAUKEGAN WORKS

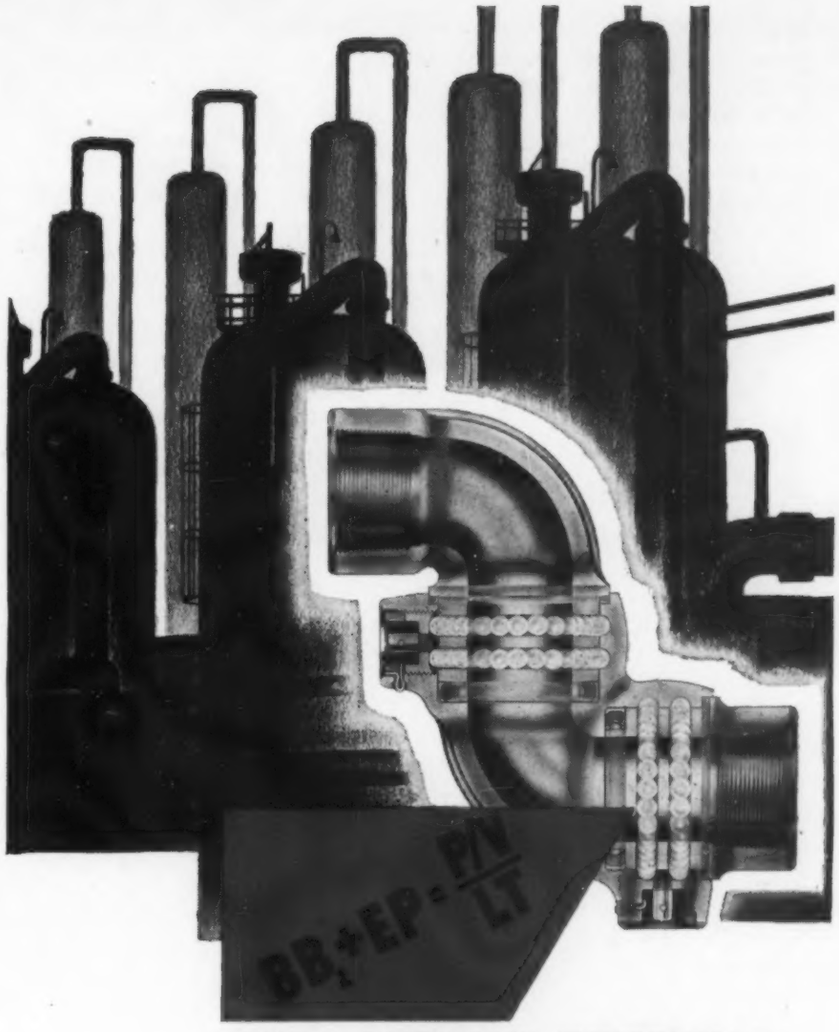
▲ An economic Santa Claus arrived prematurely when American Steel and Wire Company, U. S. Steel subsidiary, announced an expenditure of more than $1,000,000 to modernize and increase production of stainless steel wire at the Waukegan Works.

John R. Gaut, plant general superintendent, announced the project and said it would start immediately. He added the improvements will place Waukegan works among major stainless steel round wire producers in the country.

Ultramodern facilities will be housed in a new industrial building providing 100,000 square feet of floor space. The project includes facilities for a completely integrated unit, drawing and processing, from hot rolled rod to the finished product. Wire ranging from ½ inch to .004 inch in diameter in rounds and shapes will be produced in the new unit. Provisions also will be made for rod storage, heat treating, cleaning, wire drawing and finishing operations, such as grinding, polishing, straightening and cutting, spooling and packaging. Mr. Gaut estimated the new facilities should be in operation early in 1947.

SKF RESUMES PRODUCTION AS WORKERS END STRIKE

▲ More than 3,000 ball and roller bearing workers at the mammoth Philadelphia plants of SKF Industries, Inc., returned to jobs beginning December 19th, thus ending a 12-weeks strike. No wage or hour issue was involved in the strike called by the union on October 1st, despite no-strike clause in contract. The strike was called in protest to the transfer of a single employee from one department to another. The company maintained the position throughout the strike that the grievance would not be discussed until workers returned to jobs. Under the terms finally accepted by the union after expiration of contract on December 2nd, discussion of differences began on the same day workers resumed production. The union further consented to N.L.R.B. election to determine if it still is a certified collective bargaining agency.



THE CHIKSAN FORMULA

for perfect flexibility meets every demand of industry

CHIKSAN **BALL-BEARING** Swivels got their start and built their reputation for perfect flexibility in the Petroleum Industry. As this Industry became more and more important as a vital source of materials for the manufacture of synthetic products, Chiksan Swivels have proved their adaptability to every need . . . wherever flexibility is required . . . on lines handling steams, acids, alkalies, chemical compounds, gas, gasoline, etc. Many new applications have been developed to speed up production for war and for peace. There are over 500 different Types, Styles and Sizes of Chiksan Swivels. Tell us your requirements and we'll be glad to suggest those best suited to your specific needs.

REPRESENTATIVES IN PRINCIPAL CITIES

BB_2 = Double Rows of Ball Bearings
EP = Effective Packing Element
P/V = Pressure or Vacuum
LT = Low Torque under all conditions

CHIKSAN TRADE MARK REG.
BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES
CHIKSAN COMPANY
BREA, CALIFORNIA

INGENIOUS METHODS DEVELOPED TO GIVE WIDE RANGE D-C MOTOR CONTROL

▲ One ingenious method developed by Westinghouse for obtaining from a d-c motor a speed held closely constant regardless of normal changes in load, voltage, and temperature is described as follows:

On the motor-shaft extension is a smooth drum. Surrounding this drum is a cage with lengthwise slots. Resting in these slots and riding on the motor drum are carbon blocks, held in position by garter springs. The cage is connected to the driven load. The motor is arranged so that at all times its speed is above that desired, but the blocks and springs are so adjusted that at the correct rotation, the centrifugal forces lighten the pressure of the springs and the carbons slip just the right amount on the motor cylinder.

The resulting speed regulation is remarkably constant. On a motor generator set serving a torque meter, the 400-cycle output is held within one cycle for motor speed changes from 8,400 to 11,000 rpm. The output of the set is entirely an instrument load and does not vary widely. At constant load the variation for all atmospheric conditions of temperature, altitude, and humidity is approximately one quarter of one per cent.

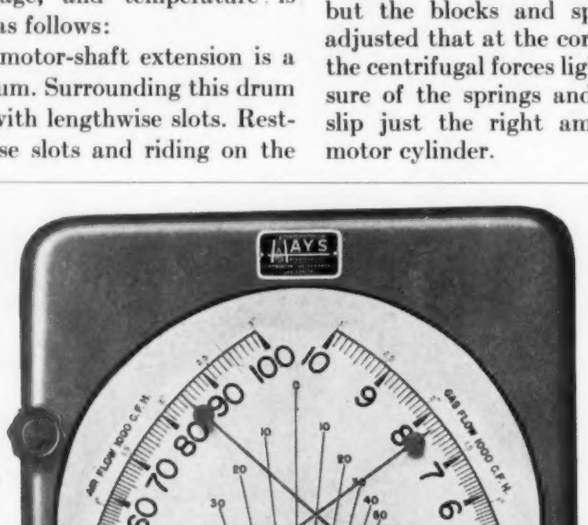
The device is flat compensated for wear but tests show barely measurable change in the surface of the friction members in 2,000 hours of operation. These carbons however must be carefully chosen, for constancy of friction characteristics with temperature and durability at high altitude.

This type of drive is not intended for use with large outputs (it has been built in sizes up to one kw), nor for wide load variations. A 50 per cent change in load produces a speed change of a little more than one per cent.

On the other hand, Westinghouse has developed a method in which greater speed ranges than the normal four-to-one can be obtained for standard d-c motors.

Four-pole d-c motors being built by Westinghouse are providing twice the speed range — or about eight to one — with no change in rated output at any speed. Essentially this is accomplished by separate control of two of the four field coils. Two adjacent poles are energized in the usual manner to supply a nearly constant magnetic flux. The remaining two poles, by a special resistor, are varied in strength from maximum, down to zero, and finally even reversed. Thus the combined field flux can be changed from a value representing the sum of all the fields to the much smaller strength of their difference. Since the armature voltage does not change throughout this entire range, the horsepower output remains constant as the speed varies.

The wide-speed-range motor is extremely useful on many machine-tool applications where constant horsepower output is needed over wider and continuously adjustable ranges than have heretofore been available from a four-to-one motor. It will eliminate in these cases the need for many of the gears previously required.



No other one instrument PERFORMS ALL THESE FUNCTIONS

INDICATE AIRFLOW

INDICATE FUEL FLOW

SHOW RATIO OF AIRFLOW and FUEL FLOW

The Hays Visio-Ratio Gage is unique among indicating instruments because it performs the functions of three indicators—air-flow, fuel-flow and ratio.

Illustrated is a Visio-Ratio Gage which measures the flow of gas to a gas fired industrial furnace and the flow of air used for the combustion of the gas. Both these scales are calibrated in rate of flow in 1000 cu. ft. per hour.

The center scale is calibrated to show the percentage of excess of deficiency of air used to burn the gas with a range of 30% deficiency to 50% excess.

The spot at which the pointers cross over the center scale indicates directly the percentage of excess of deficiency of air used for combustion, eliminating the mathematical calculations which otherwise would be required with each change in flow of gas or air. The ratio used depends on the type of flame desired—oxidizing or reducting.

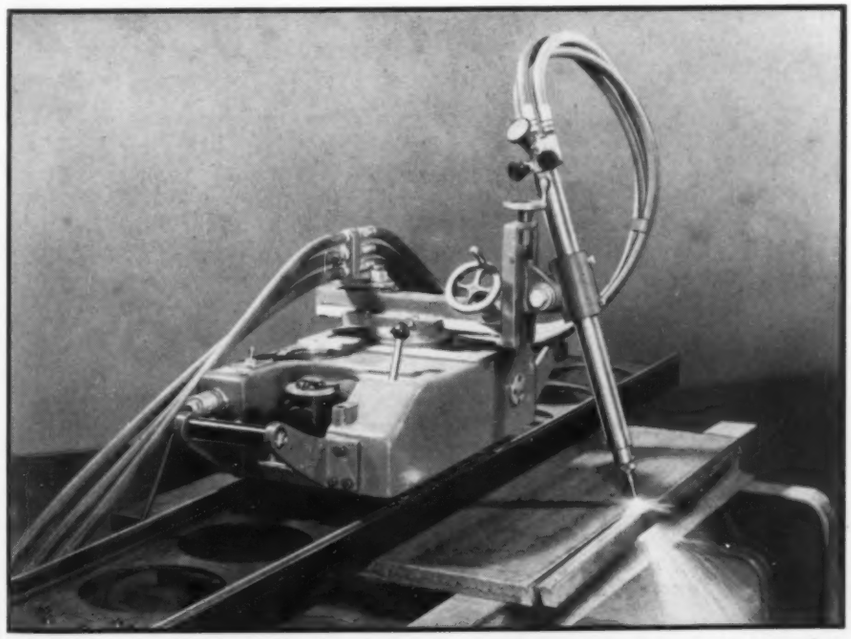
The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA U.S.A.

CARRIAGE HOLDS TOOL FOR WELDING AND BURNING

▲ A new heavy duty, straight-line machine, known as the Oxweld-Unionmelt CM-37 machine carriage has been developed by the Linde Air Products Company, unit of Union Carbide and Carbon Corporation. It can be used for carrying Unionmelt electric welding equipment, the CMA-21-B attachment for plate-edge preparation, single- or multiple-blowpipe setups for straight-line cutting, flame-hardening equipment, and the Oxweld C-45 blowpipe for cutting extra-heavy sections.

The use of high-strength aluminum alloys in the construction of the machine provide it with an ideal strength-weight ratio. Its weight as sold, without equipment (see illustration), is 87 pounds; thus it can be moved readily from job to job. Its overall dimensions are 32 in. long, 12½ in. wide, and 9 in. high, plus 2⅞ in. for the forward-reverse lever. The standard machine is equipped with a 110-volt a-c unidirectional motor of ¼ rated electrical horsepower. Reversing is accomplished mechanically through gears. Machines are supplied with speed ranges of 2 to 50 in. per min for general industrial use; and 7 to 210 in. per min for use with the Unionmelt welding process. An electric speedometer is located in the machine cover so as to be within easy view of the operator at all times. There are two calibrations — one for operation on track and one for operation directly on the workpiece.

The CM-37 will operate on CM-21 track or, where accuracy of travel is not important it can be operated on a standard 10 in., 25.4-lb I-beam. It also can be operated directly on the steel plate or other flat workpiece, if desired. With the addition of accessory equipment for plate-edge preparation, flame-hardening, heavy cutting, and other applications, this machine offers the advantages of great flexibility and adaptability.



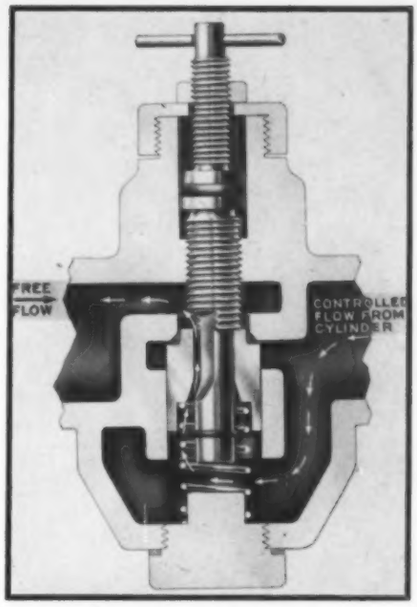
Carriage above is used to carry Unionmelt welding equipment as well as cutting torch.

SPEED CONTROL VALVE GIVES TIMING CONTROL

▲ To provide an unlimited range of selectivity in the volume of air, thereby giving split second control of the piston speed, is the purpose of the Ross speed control valve, recently announced by Ross Operating Valve Company, 6498 Epworth Boulevard, Detroit 10, Michigan.

The flow of air from the cylinder to the operating valve is regulated with absolute precision, and in either small volume or large volume, with changes taking place with smooth progression, rather than a series of "steps."

As shown by the cut-away view, both the principle and construction are very simple. There are but two moving parts — stem and poppet, with the stem so shaped as to form a venturi for the passage of air in small volume. As the threaded stem is turned downward from a closed position, incoming air in small volume is allowed to pass through the venturi into the outlet passage, increasing in volume as the stem is lowered. Continued turning of the stem causes a flange on the stem to open the poppet, permitting further increase in volume to full flow. Return air is at full flow.



Smooth progression marks regulation of valve shown in cut-away view above.

TESTER LOCATES BURIED CABLE OR PIPE

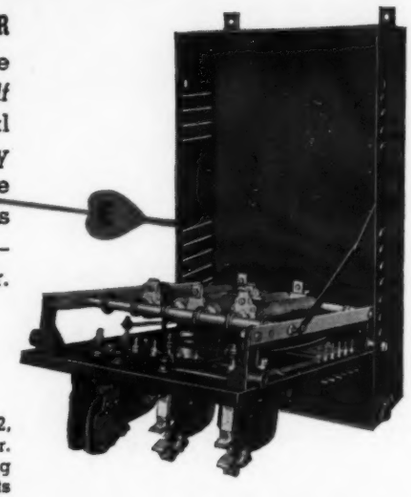
▲ Combination of facilities for the precise location and depth of buried pipe and cable with the well-known Stewart cable tester is an important improvement announced by W. C. Dillon and Company, Inc., 5410 W. Harrison Street, Chicago, Illinois.

The new product is called the Stewart cable tester and locator combined. To the location of shorts, crosses, grounds, and wet spots the new instrument now adds finding ability of most practicable service. In simple operation it tells just where cable or pipe is buried, and just how deep. It finds old cable or pipe laid many years ago on which installation records have been lost or forgotten. It locates the exact path of cable or pipe to or from buildings; finds position of a water main in street or alley; has a lamp circuit for checking all connections after test has been set up.

BULLETIN 7400 VARITIME CONTACTOR *is the* HEART *of all* CLARK HEAVY DUTY DC AUTOMATIC STARTERS

"3C" BULLETIN 7400 VARITIME CONTACTOR

The heart of these starters is the "3C" Varitime Contactor—which incorporates *within itself* an adjustable time delay—making it ideal for service as an accelerating starter on heavy duty DC motors. Since accelerating relays are unnecessary, wiring is simplified, fewer parts are required, and maintenance reduced—timing element needs no service or repair.



A. Bulletin 5370, Size 5, Type R, Form 3 AL Non-Reversing, Dynamic Braking, Adjustable Speed Starter,—cover removed. This control has Type FL (Field Loss) Relay, for preventing motor run-away if field should burn out or in some way become de-energized.

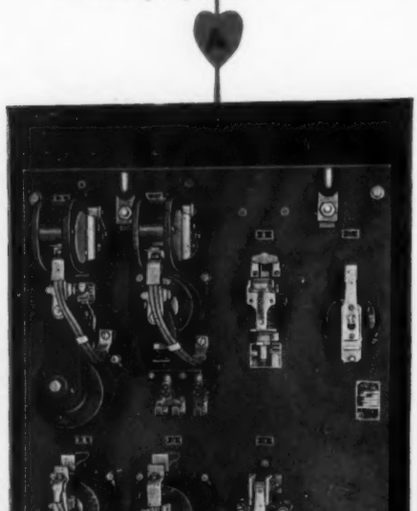
B. Bulletin 5370, Size 2 Type RB, Form 2L Reversing, Dynamic Braking Starter. Bulletin 5370 Starters are suitable for use with Shunt or Compound Wound DC Motors on drives where frequent starting is required as with various machine tools, fans, blowers, pumps, etc.,

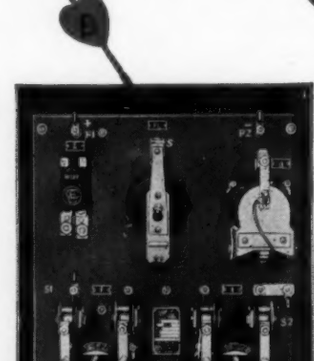
C. Bulletin 5370, Size 2, Type P, Form 2, Non-Reversing, Constant Speed Starter. Illustration shows control without enclosing cabinet. NEMA Type 1 enclosing cabinets are standard on Bulletin 5370 Starters, but other types of enclosures are available for specific applications.

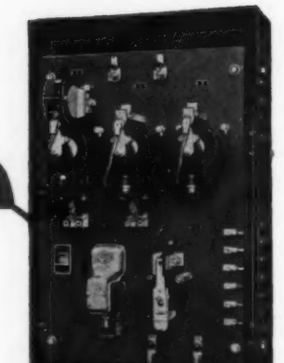
D. Bulletin 5380, Non-Reversing Adjustable Speed Heavy Duty Mill Type Automatic Starter—cover removed. These starters are used in heavy-duty applications and in connection with Shunt or Compound Wound, Constant or Adjustable Speed DC Motors.

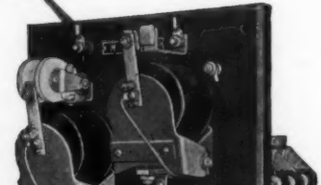
E. Bulletin 5380 Starter, same as "D", showing swing-out arrangement on the slate permitting easy access to rear of panel for routine maintenance.

Ask for descriptive Bulletins 5370 and 5380









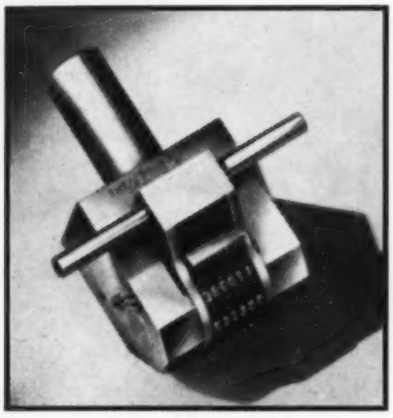
THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL

ALLOYS LIGHTEN NUMBERING MACHINES

▲ Constant scientific advance in the engineering and design of numbering machines by Acromark has resulted in greater strength and lighter weight.

Development of a minimum of parts for positive automatic action has evolved into scientific construction of those parts for maximum strength and minimum weight. The use of new alloy tool steels of maximum resistance to the various stresses such a machine must withstand, have made this development possible.



Alloy steels that can be controlled in hardening to close limitations together with new shock resisting qualities contribute to this advance.

Further information may be obtained upon application to The Acromark Company, 338 Morrell Street, Elizabeth 4, New Jersey.

ABRASIVE COMPANY CHANGES NAME

▲ A new name now identifies Abrasive Company of Philadelphia. For a more specific designation of company and product, the company's corporate name now is Simonds Abrasive Company.

Abrasive Company, founded in 1892, has been a leading manufacturer of grinding wheels and other abrasive products for over half a century. In 1927 the company was purchased by Simonds Saw and Steel Company of Fitchburg, Massachusetts, manufacturers of saws, files, machine knives and steel specialties since 1832. It was at that time that Abrasive Company became a division of the Simonds organization.

Simultaneous with the change in name, a new Simonds master trademark will be officially adopted. This new trademark will identify all products of Simonds Abrasive Company as well as those manufactured by all branches of the Simonds Saw and Steel Company.

There is no change in ownership, management or policy.

AIRCO TO BUILD NEW RESEARCH LABORATORY

▲ Work has begun at New Providence (near Summit), New Jersey, on the construction of a new mechanical research laboratory for Air Reduction and subsidiary companies, which will substantially augment their position in the oxyacetylene industry.

The new laboratory will house Air Reduction's apparatus research department, which is responsible for research in and development of processes and apparatus for using industrial gases and the electric arc, particularly in the cutting, welding and treating of metals. These processes are vitally important to modern American industry.

The laboratory will have a floor area of 78,000 square feet, the size of the average city block. Two small auxiliary service buildings will be adjacent. More than 150 engineers, metallurgists, physicists, chemists and laboratory technicians will be employed in the laboratory, as well as a number of instrument makers and skilled machinists for model making.

The buildings are of the latest ultra-modern, functional design, with all-welded steel frames, reinforced concrete foundations and floors, and brick walls with continuous steel-sash windows. The main building will be two stories in height, except for the center portion, where a third story will house a modern cafeteria, having access to a roof terrace.

Interior features are welded pipe lines for the distribution of oxygen, acetylene, nitrogen and other industrial gases, especially constructed rooms for experiments in the combustion of gases and the processing of metals, modern fluorescent lighting fixtures, and movable steel partitions permitting maximum flexibility of interior working space.

A technical library will be provided and an historical exhibit of welding and cutting equipment dating back to the turn of the century.

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TITANIUM CONTROLS CARBIDE, REDUCES CORROSION IN STAINLESS STEELS

▲ One of the largest uses for titanium in metallurgy is for carbide control in stainless steel. The austenitic nonhardenable types of stainless, coming under the common classification of 18-8, are subject to a grain-boundary precipitation of carbide, at certain moderately high temperatures, which makes the steel very susceptible to intergranular corrosion. When this occurs to a serious extent the metal may disintegrate into a powder, and even moderate attack results in cracking and loss of strength. Soon after this difficulty with stainless steel was first announced it was discovered that adding sufficient titanium to combine with all the carbon in the steel prevented the grain boundary precipitation, since titanium carbide forms at a much higher temperature and occurs scattered through the grains. Other carbide-stabilizing agents were suggested later, and have found considerable use, but titanium has been used longer and in larger quantity than any other agent for this purpose.

In heat resisting steels titanium is also being found increasingly useful. In the lower-carbon grades, it is used to prevent air-hardening and eliminate the necessity for annealing and slow cooling every time the steel is heated. In the higher-carbon grades, titanium greatly refines the grain with a corresponding improvement in the mechanical properties. The high temperature strength of alloy steels is also improved by titanium when used correctly. For instance in a series of comparative stress-rupture tests, where a plain 0.07 per cent carbon 18-8 stainless steel failed in less than 15 hours at 1500 F stressed at 8000 psi, a similar steel with 8 times as much titanium as carbon required more than 47 hours for failure under the same conditions. The life of 5 per cent chromium, ½ per cent molybdenum steel when stressed at high temperature is also greatly improved by controlled amounts of titanium, as explained in detail in a current ASM publication.

Furthermore the oxidation-resistance of such steels is improved by titanium. Data supporting this statement have appeared in several publications, and are illustrated by Figure 1, which shows some oxidation test specimens, cleaned by sand-blasting, after 1001 hours at 1650 F in a summer atmosphere. Their analyses and scale losses in this test were as follows:

Oxidation test specimens of 5 per cent chromium-molybdenum-silicon steels, heated 1001 hours at 1650 F, cleaned by sand-blasting. No. 1 at the left contained titanium, and No. 3 at the right contained aluminum.

Specimen No.	1	2	3
Carbon, per cent	.15	.12	.19
Manganese, per cent	.74	.28	.26
Silicon, per cent	1.49	1.42	1.26
Chromium, per cent	5.50	5.20	5.03
Molybdenum, per cent	.55	.50	.51
Aluminum, per cent	—	—	.84
Titanium, per cent	1.65	—	—
Scale loss, grains psi	0.11	0.57	0.52

The pitting type of oxidation exhibited by samples 2 and 3 in Figure 1 has not been found in titanium steels, and would of course make even a small weight loss, as in these samples, much more serious in actual use.

RUST TO BUILD NEW INDUSTRIAL FURNACES

▲ Rust Furnace Company, Pittsburgh, Pennsylvania, has begun construction of three large industrial furnaces for Chicago Bridge and Iron Company at Chicago, Illinois, Greenville, Pennsylvania, and Birmingham, Alabama.

The furnaces at Chicago and Greenville will be used for the stress relieving of welded pressure vessels. The other, at Birmingham, Alabama, will serve primarily for the heating of heavy plates prior to forming and for alloy heat treating at high temperatures.

Largest of the three furnaces, which is 85 ft long by 15 ft 2 in. wide by 16 ft high (from car floor to spring of arch), and has a car width of 11 ft, is being erected at the company's home plant in Chicago.

The stress reliever at Greenville has the same cross section as the Chicago furnace, but is 20 ft shorter in length. The Birmingham furnace is 42 ft 6 in. long by 17 ft wide by 8 ft 9 in. high.

The structures at Chicago and Greenville have sprung roofs and the Birmingham furnace has a suspended roof.

Rust designed and erected the stress relieving furnace at the Chicago Bridge and Iron Company's plant at Birmingham in 1937. It is similar to the new installations at Chicago and Greenville.

MACHINE SHAKES COAL FROM HOPPER CARS

▲ Working like a giant Paul Bunyan, mythical strong man from ancient legend, a new machine has been invented which literally shakes the sticky stubborn coal out of the cars.

But unlike Bunyan, who tied his victims into pretzels, this modern strong man of the railroads leaves the coal cars unscathed and doesn't even scratch the paint.

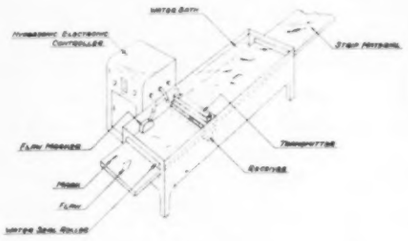
Officially titled the car shaker, the miracle machine was designed and built by Robins Conveyors, Inc., Passaic, New Jersey, pioneer in bulk materials handling equipment. Here's how the machine works:

The machine is placed on top of a loaded car and a button is pressed to start an electric motor. Seismic action results and the coal flows out the bottom of the car. About two minutes is the average time.

Final testing of the equipment was completed recently by the C. & O. Railroad at the Carbon Fuel Company in Charleston, West Virginia, and one car was unloaded in a minute and a half. Other tests have been conducted on railroad lines in the New Jersey area. Longest time required was seven minutes, with the coal extremely wet. Only two men are required to operate the equipment.

SUPERSONIC WAVES USED TO DETECT FLAWS

▲The story of the Brush Hypersonic analyzer, like that of many other unusual developments, starts in World War II. In 1944, the United States government embarked upon a heavy schedule of rocket projectile production. Uniformity in the composition of the rocket sticks and absence of voids, flaws, and foreign material, were imperative. The presence of any flaws in the powder sticks would result in a premature explosion, rather than a uniform propelling action and would be disastrous.



At the start of the rocket projectile program X-ray was used for inspection of the rocket powder sticks. This was a costly and time consuming operation and was further hampered by a serious shortage in X-ray film. In seeking a more practical and expedient method of inspection for the greatly expanded program, the Hercules Powder Company began to consult with various electronics manufacturers.

The Brush Development Company was approached with the problem and, due to its long experience with piezoelectric crystals and experimental work in supersonics, was able to build an equipment to handle this most exacting inspection job. The Hypersonic analyzer, developed by Brush, replaced X-ray and was thenceforth used in the entire U. S. rocket projectile program.

Since the end of the war the Brush Development Company has been experimenting with the application of the Hypersonic analyzer to inspection and flaw detection in various industrial fields.

The Hypersonic analyzer consists essentially of three parts: 1. a piezoelectric crystal transmitter, 2. a piezoelectric crystal receiver, 3. a signalling or marking device.

The crystal transmitter sends supersonic waves through the material being examined. These waves are picked up by the crystal receiver and a constant result is registered until flaws, defects or a definite change in density are encountered. The actual detection and identification of the flaw or defect may be indicated in any of several desired ways — on a meter, by signal light or a bell, or a relay hook-up may be used to make whatever physical markings may be desired.

Generally speaking, the use of a liquid as the transmitting medium is desirable in Hypersonic inspection. The reason for this is that fluids such as water and oil give better coupling between the transmitter, the material under inspection and the receiver, at supersonic frequencies. However, in certain instances air or other gases make a satisfactory transmitting medium. The choice of medium depends upon the particular material being examined and also the physical possibility of exposure of the material to the medium.

Since the Hypersonic analyzer can detect any change in density of a wide variety of materials, its possible uses are almost limitless. Immediately, it perhaps offers greater possibilities to the metals and plastics fields than to any others. In the rolling of sheet steel, for example, the Brush Hypersonic analyzer will accurately detect and identify the location of "pipes," "cat's eyes," "blisters" and laminations. Moreover, it will detect and identify such defects early in the manufacturing process, thus making possible very appreciable savings in time and money expended on finishing. Experiments indicate that flaws as small as one one-thousandth inch in thickness can be detected by the analyzer. Such flaws cannot be detected by X-ray or any other known inspection method.

REACTOR CONTROL PERMITS A-C HOISTS

▲ The hope of factory owners to eliminate need for a direct-current distribution system around their plants is in fair way to being fulfilled. The last stronghold of constant-voltage d-c motors in most factories is for overhead cranes, where wide speed ranges and dynamic breaking obtainable with series machines are desirable. However, a new system has been developed by Westinghouse in which a wide speed variation at different loads and improved lowering characteristics are possible with induction motors. It is accomplished by doing just what electrical engineers generally seek to avoid, unbalancing the voltages of a polyphase system. By the use of a reactor in one primary line, the voltages applied to the terminals of a three-phase wound-rotor motor are deliberately unbalanced, causing the motor to operate at increased slip for reduced hoisting, and for better controlled lowering speeds. By the use of a saturable-core reactor the amount of inductance inserted can be varied from a little to a great deal. When a small amount of reactance is applied to the circuit the motor operates in the usual manner. The more reactance that is introduced into one primary line, the more nearly single-phase operation is approached. Because the reactor is continuously variable and since its impedance varies with speed as well as by the switch position selected by the hoist operator, great flexibility of power and speed are available while handling a load or an empty hook.

MACHINE TRIMS BOTH PLATE EDGES AT ONCE

▲ Substantially reducing the time required for side edging or trimming of plates preparatory to their being automatically welded, an entirely new trimmer, the Thomas Plate Edging Machine, has been perfected by Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania.

By simultaneously trimming both side edges in one pass, the plate is ready for automatic butt welding in a very small fraction of the time required by older conventional methods.

The Thomas Plate Edger shears the material rather than planes it. The shear cut, in addition to being more rapid, results in a tighter, more accurate joint between two plates than is obtained by any other production method, according to the manufacturer. Two major operational factors assure this result:

First, the plate is held perfectly flat while under the shear blades. Thus mill wave, which is present in the majority of plates, is eliminated when the cut is made. Second, the plate is carried through the entire shearing cycle in the same relative position. This is accomplished by a combination of stop gauges; extremely rigid holding of the work; and accurate guiding methods in passing tha plete through the machine.

New Literature

▲ Research bulletin No. 1 of the Acid Open Hearth Research Association, "Acid Open Hearth Slag Fluidity and Its Significance," describes the development of a standard slag fluidity test, based on scientific principles. Development and standardization of the test has permitted correlation of slag fluidity data between member plants of the Association. Using actual plant data from a large number of heats, it is shown that as the slag fluidity decreases progressively during the course of a heat, the SiO_2 content of the slag and the metal temperature increase while the FeO content and the density of the slag decrease correspondingly. A description is given of a simple and rapid control procedure based on such fluidity relations from which it is possible to determine: (1) the point at which the charge is melted; (2) the amount of ore and/or limestone to be added, and the proper time for such additions; and (3) the point at which the heat should be blocked. An appendix includes a comprehensive survey of the scientific literature dealing with the absolute viscosity of molten slags and glasses.

Copies of the bulletin may be obtained at $1.00 each by writing in care of the A. O. H. R. A., P. O. Box 1873, Pittsburgh, Pennsylvania.

▲ An eight-page folder "Conversion Factors and Formulas for Electrical Engineers" has just been published by the I-T-E Circuit Breaker Company. It contains over 600 conversion factors commonly used by electrical engineers as well as definitions of basic electrical units, prefixes, mensuration and temperature conversion factors. The lists are arranged for use in a loose-leaf binder or for desk or wall mounting. Conveniently indexed, a wealth of electrical information is made instantly available. The factor tables have been lacquered to add durability. Write for free copy to the I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pennsylvania.

▲ A four-page bulletin, just issued by the Crocker-Wheeler Division of Joshua Hendy Iron Works, Ampere, New Jersey, describes the company's Sealedpower motor. An exclusive design, the Sealedpower motor was developed for use in dusty locations, in places where there is excessive moisture, and for all applications where the conventional alternating-current, totally-enclosed, fan-cooled motor has been used in the past. It is available in sizes from 2 hp to 15 hp.

The bulletin, besides containing a detailed description of the features of the motor, includes a cutaway view and pictures of six typical applications. Laboratory tests, made before the motor was placed on the market in 1941, are illustrated and described.

▲ A unit oil atomizer designed to provide atomized oil for burners of small capacity is described and illustrated in a new bulletin by Bloom Engineering Company of Pittsburgh, Pennsylvania.

The Bloom unit atomizer provides an oil application for small gas burners or a multiplicity of small oil burners served by a preheated air system.

Operating on high pressure steam, the atomizer creates a steam-oil emulsion and dissipates it to the burners. One unit supplies from 3 to 10 burners and will operate the average forge furnace or a small boiler.

The new bulletin features a typical Bloom unit atomizer system layout with complete descriptions of capacity and operation.

The oil outlets of the Bloom atomizer project into the mixing chamber of the unit preventing unatomized oil from entering burner lines. Each outlet has an individual shut-off valve.

For a copy of the new Bloom bulletin write direct to Bloom Engineering Company, 857 West North Avenue, Pittsburgh, Pennsylvania.

▲ Types of loads and economical methods of handling them are dealt with in four bulletins issued by The Elwell-Parker Electric Company, Cleveland, builder of power industrial trucks. These bulletins supplement the booklet "Industrial Logistics: A Survey for Management" recently issued by the company. They are titled "The Logistics of Boxes;" "The Logistics of Barrels;" "The Logistics of Bags;" and "The Logistics of Bales."

A large proportion of raw materials, semi-finished and finished products are handled in boxes, barrels, bags or bales, or their equivalents, and the purpose of the bulletins is to assist manufacturers and distributors to determine the best form and methods of handling the loads.

Copies of the bulletins and booklet may be obtained gratis by addressing The Elwell-Parker Electric Company, 4205 St. Clair Avenue, Cleveland 14, Ohio.

▲ The contract division of Thomas Machine Manufacturing Company, of Pittsburgh, Pennsylvania, announces publication of a new five-section catalogue illustrating numerous types of special machinery and contract machine work it is equipped to build to customers' designs and specifications.

Section one of the new catalogue covers equipment built for steel mills and allied industries. Dredge pumps, lock and dam machinery and dredge ladders built to U. S. Government designs and specifications are pictured throughout section two. Section three is devoted to miscellaneous special machinery, including lathes and other equipment. In section four Thomas-built dies, jigs and fixtures are illustrated; while the fifth and last section is devoted to miscellaneous machine work.

The forepart of the catalogue shows interior views of the Thomas plant and facilities available for the overhauling, reconditioning and construction of all types of machinery.

▲ The ECO Engineering Company, 12 New York Avenue, Newark 1, New Jersey, has issued an illustrated instruction sheet describing the installation and operation of ECO gearless pumps as used for water and oil circulating. The sheet includes pump dimensions, capacity charts, prices and several typical methods of pump coupling. Address Department 81.

▲ Manufacturers small as well as large will find important news in a new and comprehensive illustrated bulletin just issued by W. C. Dillon and Company, Inc., 5410 West Harrison Street, Chicago 44, Illinois.

The bulletin (8 large pages in colors) goes into considerable detail on testing tensile, compression, transverse and shear, for the widest range of materials and all shapes of specimens. Supplementing the bulletin, free specimen charts compiled by Dillon engineers are offered on request.

▲ A new catalogue, describing a complete line of marking equipment, is announced by the Acme Marking Equipment Company, of Detroit. Illustrated throughout, it includes

ELECTRIC TRUCKS
PALLETIZED LOADS
PHILCO BATTERIES

Big Three in War and Peace!

Now that wide war-time experience with unit loads has proved battery-powered electric trucks the most flexible, safe, cost-saving equipment for handling materials and finished goods—make this knowledge pay off! Go the whole way by powering your electric trucks with the amazing new Philco "Thirty", the high capacity battery that gives 30% longer life! It will save you money. Write for the new Philco "Thirty" catalog.

Philco Corporation, Storage Battery Division, Trenton 7, New Jersey

PHILCO FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

more than 150 different products in the marking field, among them Acme's branded line of Ram's Head steel stamps.

One feature of this new catalogue is the thumb index in the front and back of the book. By placing a thumb opposite the listing in the index, the reader is guided to the proper portion of the book by imprints on each page. A carefully-planned classified arrangement makes for quick reference to the materials desired.

Copies may be secured without charge by writing the Acme Marking Equipment Company, 2222 West Fort Street, Detroit 16, Michigan.

▲ An up-to-date price list and catalogue of Airco arc welding accessories has just been published by Air Reduction. This 12-page booklet illustrates and describes a complete line of accessories for all types of arc welding machines and operations.

Types of equipment covered include: electrode holders, graphite electrodes, welding cable, cable connectors, and cable lugs. Also listed are: welding helmets, goggles, face shields, headgear, aprons, gloves, and sleeves.

An additional section is devoted to Airco heliwelding equipment which was developed in response to pressing demands for a better method of welding magnesium.

Copies of this booklet may be obtained by writing for catalogue No. 130 to Air Reduction, 60 East 42nd Street, New York 17, New York.

▲ "Arc Welding Electrodes," a new 32-page illustrated catalogue published by Wilson Welder and Metals Company, Inc., is designed to guide electrode users in the selection of the right electrodes for any specific job.

This catalogue supplies complete data on the proper electrodes to be used for all types of work on a wide variety of base metals, and describes the approved welding procedures for each application.

Electrodes are recommended for use on mild steel, alloy steels, low alloy high tensile steel and stainless steels. Additional sections are devoted to electrodes designed for nonferrous metals such as aluminum bronze, aluminum, and manganese bronze.

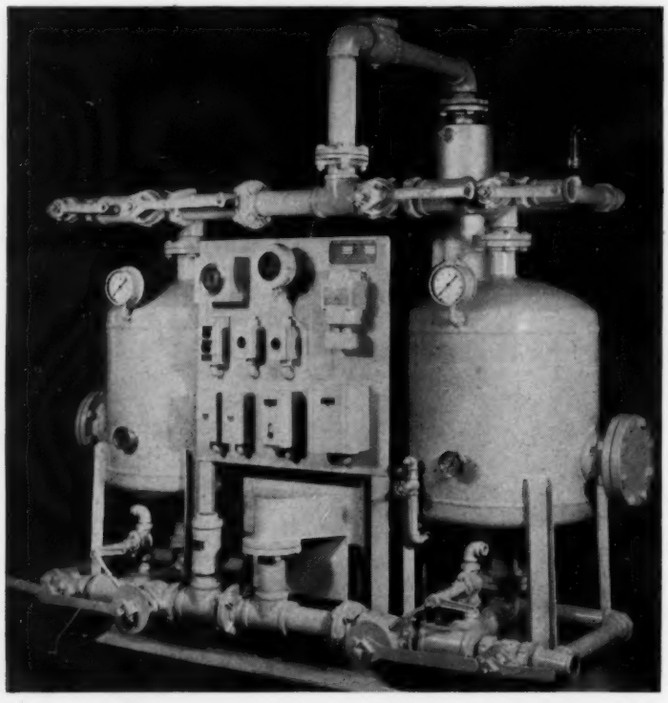
Chemical analyses, specifications, and other engineering data are supplied for each electrode.

Copies of this booklet may be obtained from Wilson Welder and Metals Company, 60 East 42nd Street, New York 17, New York.

▲ Page Steel and Wire Division of American Chain and Cable Company, Inc., Monessen, Pennsylvania, recently issued a new 8½ x 11 in., 8-page booklet titled "Guide to Everyday Welding." It is offered as a guide in the selection of the proper type of electrode or gas welding wire to use for welding various types of materials, structure and equipment.

The information is arranged in easy-to-find tabular form, indexed by industries, listing types of jobs and equipment on which welding is used, showing character of welds and types of electrodes or gas welding rods for each application.

A condensed chart is included which shows the physical properties, correct recommendations and analysis of weld metal deposit for stainless steel, carbon steel, shielded arc and bare and sub-coated electrodes and gas welding wires. Copies of the booklet can be obtained by writing to Page Steel and Wire Division, American Chain and Cable Company, Inc., Monessen, Pennsylvania.



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AIR • GASES • LIQUIDS

at pressures from atmospheric to 1500 lbs.

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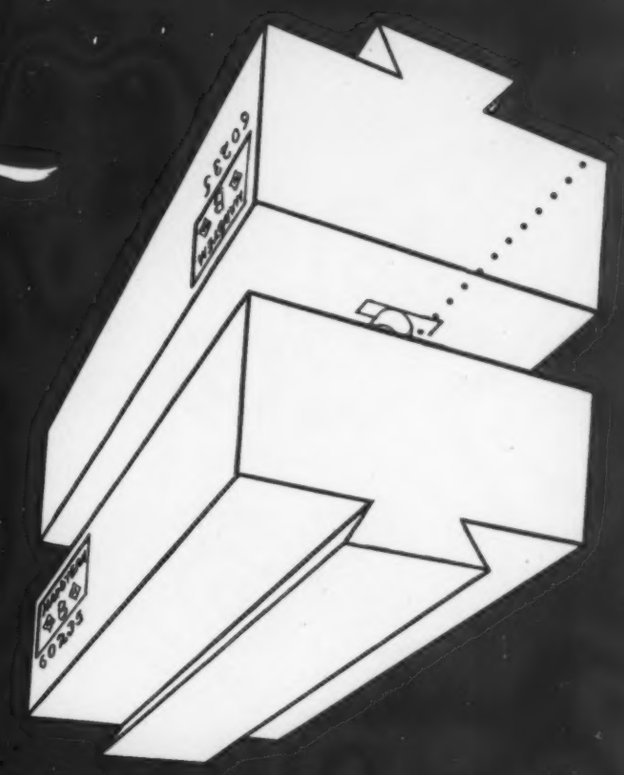
to lower forging costs



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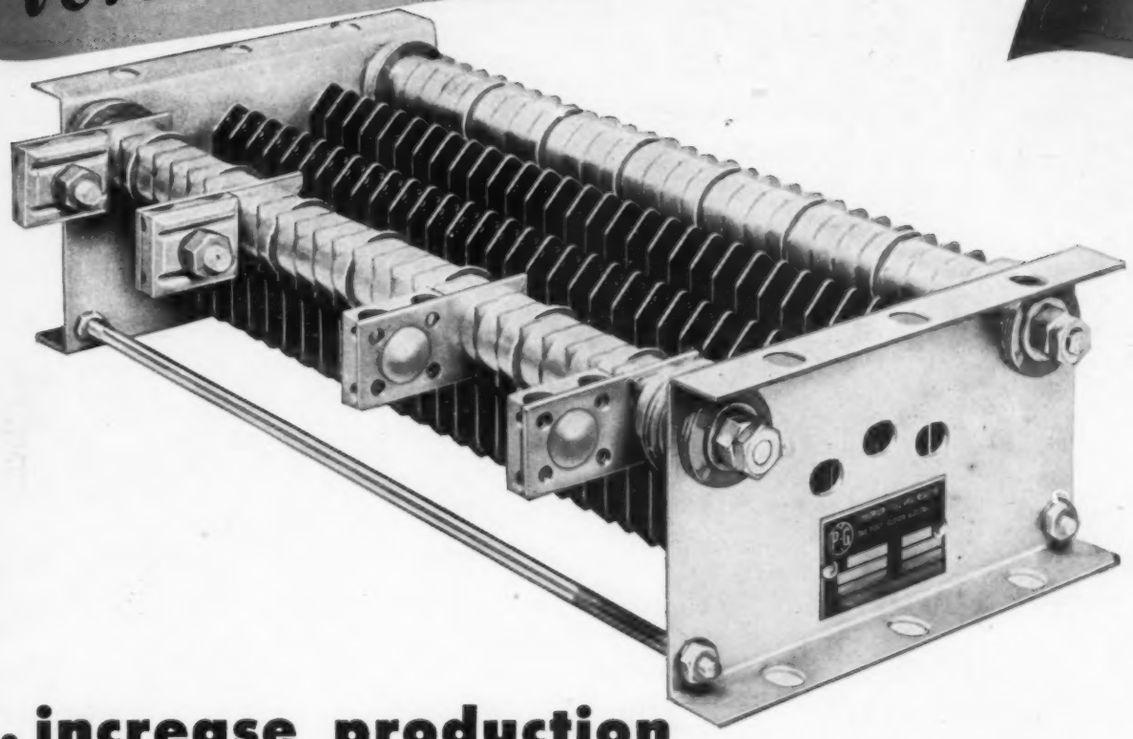
Nonbreakable P-G STEEL GRID Resistors



. . . increase production thru constant, trouble-free service

Nonbreakable steel construction, provision for expansion, and ample ventilation make P-G Resistors give unusually long and constant, trouble-free service. This absence of resistor trouble is one reason P-G users obtain steadier and more regular production from motor driven equipment. With less electrical maintenance more machine production hours are available. On your next tough resistor application, where trouble is frequent, try P-G.

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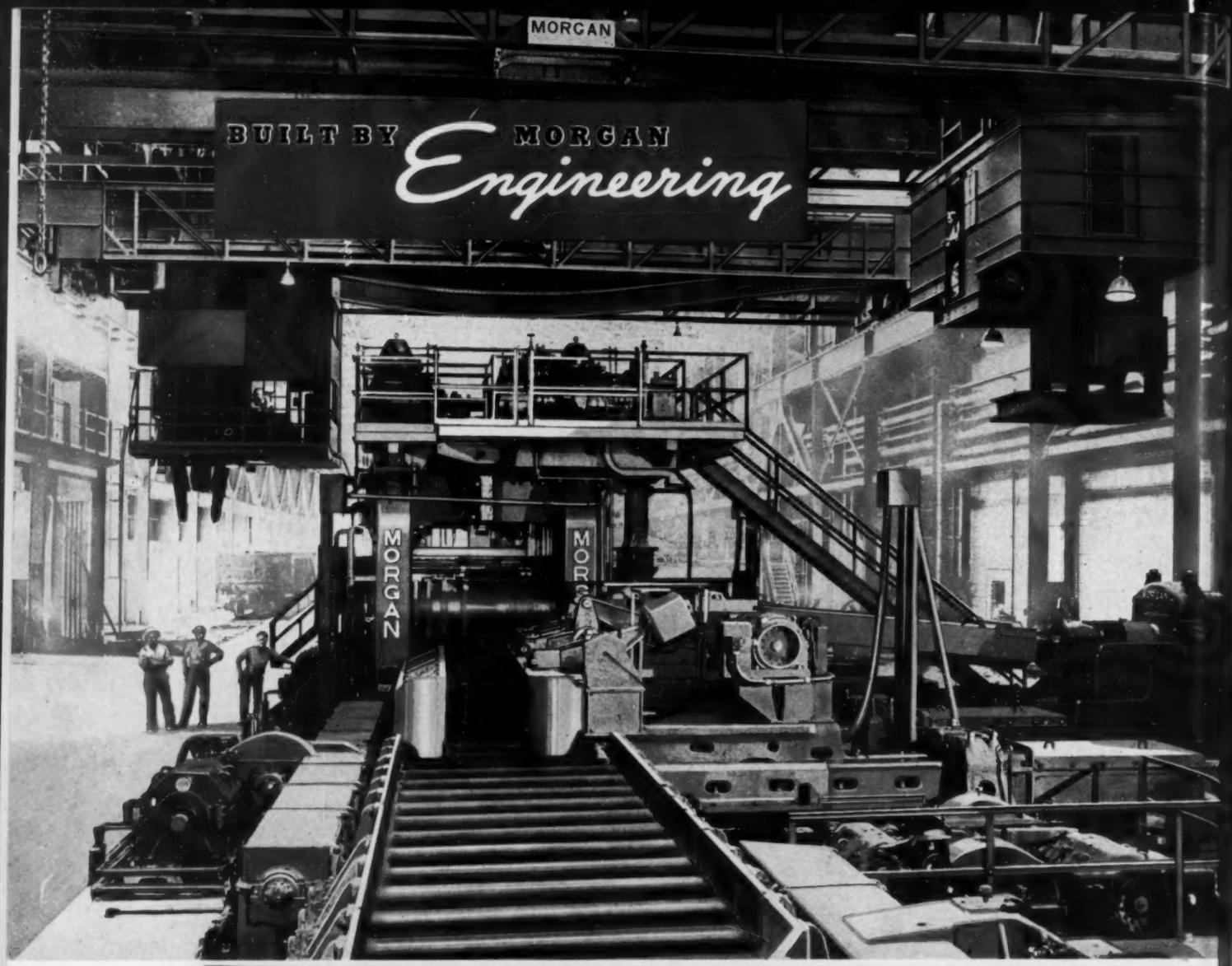

MORGAN "36" TWO-HIGH BLOOMING MILL

GROUPED OVER THE MILL IS A MORGAN 7½-TON SOAKING PIT CRANE AND A MORGAN 200-TON 81'-3" SPAN UNIVERSAL TYPE INGOT STRIPP

With this Mill was furnished Auxiliary Equipment as follows — Front and Rear Tables with Manipulator — Approach Table — Ingot Buggy — Runout Tables — Slab Shear with Gauge — Crop Hoist — Pushers — Conveyor — Skid Bed and Furnace Tables.

Above is shown a Morgan 36" two-high blooming mill complete with double manipulator, front and rear tables. Three mills of this type were recently furnished prominent mid-west steel producers. Housings are one-piece steel castings of the closed top type. Top roll balance is of the counterweight type.

Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings. Screw-down drive is arranged to provide crane hook access when changing guides. Provision is made for automatic lubrication and exclusion of scale and dirt.

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Personnel News

James D. Kelly has rejoined the staff of the Association of Iron and Steel Engineers resuming his position as business manager of the Iron and Steel Engineer and other publications of the Association. Since April 1944, Mr. Kelly has been on leave of absence during which time he served in the United States Navy. Most of his service has been in the Pacific war theater.

JAMES D. KELLY

E. J. Protin has been appointed vice president in charge of a newly created products development research division, effective January 1, 1946.

At the same time, **J. H. Morrison,** who rejoined the company last October as general works manager was named vice president in charge of operations, a post which Mr. Protin has held since February, 1942.

Mr. Morrison, a native of Struthers, Ohio, attended the University of Pittsburgh, and worked with Pittsburgh Steel from 1936 to 1940, when he left to become vice president in charge of operations of the Sharon Steel Company. He resigned to rejoin Pittsburgh Steel three months ago.

Mr. Protin, a director of Pittsburgh Steel, has been particularly active in developing products for the oil industry.

A. F. Nelson, roll sales engineer for Continental Foundry and Machine Company for the past 12 years, retired November 1. For over fifty years, Mr. Nelson was in charge of the roll department at the Steelton plant of Bethlehem Steel Company, during which period the department grew from a one-lathe roll shop to its present high efficiency. For the past twelve years, he has covered the Eastern territory for Continental. Having passed his 80th birthday last May, Mr. Nelson was perhaps the oldest roll designer in the country in active duty. He was also the designer of the rail-structural mill at Steelton.

E. G. Price has been appointed general superintendent of National Works, National Tube Company, at McKeesport, Pennsylvania, succeeding **R. M. Overton** who was promoted to the staff of **B. H. Lawrence,** vice president of engineering, United States Steel Corporation of Delaware.

Mr. Price has held many important positions in the operating department of National Tube, including the general superintendency of the company's Lorain, Ohio, plant. He is a native of Dubois, Pennsylvania, and was graduated from Penn State College with a metallurgical engineering degree. He began with National Tube as a blast furnace employee at Lorain in 1922.

Mr. Overton was general superintendent at National Works since 1942. Graduated in mechanical engineering at the University of Illinois, his career began with National Tube in 1924 as a power engineer.

B. C. Colcord, who has been assistant vice president of operations for National Tube Company in Pittsburgh, has been appointed general superintendent of the Lorain, Ohio, works of that company. This move emphasizes the growing importance of Lorain Works, where an important expansion program is under way.

L. F. Sattele has been named assistant general superintendent of the plant.

Mr. Colcord, who brings to Lorain a wide experience in operating positions in the steel industry, was born in Elk County, Pennsylvania and graduated from the University of Michigan in mechanical engineering. He began his career in the steel industry working summer vacations at the Clairton, Pennsylvania plant of Carnegie-Illinois Steel Corporation, and after his graduation joined Jones and Laughlin. Later he was associated with several other prominent steel manufacturing companies and joined National Tube in 1936.

Walter F. Nicoden has been appointed assistant general superintendent of Edgar Thomson Works, Carnegie-Illinois Steel Corporation, succeeding **John Lloyd** who retired December 31.

A graduate of Penn State with a B.S. degree in metallurgy, Mr. Nicoden was first employed by U. S. Steel's American Sheet and Tin Plate Company while at college to supplement his schooling. After graduation in 1932 he returned to the company as assistant shearman.

Mr. Nicoden joined Carnegie-Illinois in 1933 as a metallurgical observer at Homestead Works. In 1937 he became assistant superintendent of open hearth No. 4 and three years later was made superintendent of the plant's entire open hearth department, the position he leaves to assume his new duties.

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Extra Strength
MAGNETS

A 55" Double strength magnet.

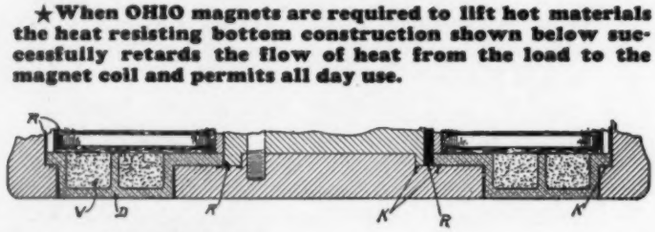
The OHIO 6 pancake coil magnets in the 55" and 65" diameters will average 35% better lifts than the standard magnets.

The OHIO 8 pancake coil magnets will average 75% more than the standard magnets.

Labor cost per ton and time required to handle are both reduced correspondingly.

Numerous repeat orders testify that performance equals or exceeds the statements above.

★When OHIO magnets are required to lift hot materials the heat resisting bottom construction shown below successfully retards the flow of heat from the load to the magnet coil and permits all day use.



Have you a problem requiring fast lifting or lifting of hot steel?

The OHIO Electric Mfg. Co.

5907 Maurice Avenue Cleveland 4, Ohio

Mr. Lloyd retires after 46 years of continuous service in the steel mills. He was first employed at Carrie Furnaces in 1899 as a tracer and moved to Mingo Works in 1901 as a draftsman. He has been at Edgar Thomson Works since 1903, where he was successively draftsman, roller, general foreman of rolling, superintendent of rolling and since 1933 assistant general superintendent.

On July 1, 1944, he was retired and immediately reemployed so that his experience and ability might be utilized during the war period.

Clarence E. Abbott, vice president of the Tennessee Coal, Iron and Railroad Company, retired December 31.

Widely known throughout the mining engineering profession, Mr. Abbott has spent 43 years with subsidiaries of United States Steel Corporation. His career began with employment in Eveleth, Minnesota, as assistant mining engineer in the Fayal District of the Oliver Iron Mining Company. He came to Birmingham as chief engineer of iron mines and quarries for the Tennessee Company in 1906. He became general superintendent of iron mines and quarries in 1910, manager of iron and coal mines and quarries in 1925, and vice-president in 1930.

Fred T. H. Youngman, formerly vice president of the Jessop Steel Company was elected to the office of president. **R. Edson Emery,** former president, was elected to the office of chairman of the board. **W. C. Buchanan,** president and director of Globe Steel Tubes Company of Milwaukee, was elected a director.

George L. Davis, formerly general staff manager of sales for Carnegie-Illinois Steel Corporation, has joined Continental Foundry and Machine Company in a sales capacity and is working on special assignments. **Edward Mitchell,** identified with the casting industry for the past 35 years, has become associated with Continental as manager of alloy casting sales.

Harold J. Ritter was elected president and treasurer and a member of the board of directors of the Norma-Hoffmann Bearings Corporation, succeeding **O. P. Wilson** who had resigned.

Prior to his resignation from the Norma-Hoffmann Bearings Corporation, which became effective June 30, 1944, Mr. Ritter was with the company for 28 years, having held many company posts including that of sales manager, assistant secretary, secretary, vice president and director.

Dr. Stewart G. Fletcher has been engaged by Latrobe Electric Steel Company as chief research metallurgist to direct an expanded research program. He will have headquarters at the Latrobe, Pennsylvania, plant.

In recent years, Dr. Fletcher has conducted special metallurgical research projects as a research associate at Massachusetts Institute of Technology. A member of the American Society for Metals, he was awarded the society's Howe Medal in 1945 for his work on the best technical paper of the year. He is a graduate of Carnegie Institute of Technology, and received his doctorate in metallurgy from M.I.T.

At Latrobe, Dr. Fletcher will head and expand a metallurgical research department designed for continued research in all phases of high speed steel, tool steel and die steel production.

FRANK E. NUTT

Frank E. Nutt has been named assistant sales manager of the Crocker-Wheeler Electric Manufacturing Company, division of Joshua Hendy Iron Works at Ampere, New Jersey. He was replaced at his former post as manager of the company's Washington, D. C. office by **A. M. R. Lawrence,** of Chevy Chase, Maryland.

Mr. Nutt is a native of Colorado, graduate of the University of Denver, and has held positions in the General Electric Company at Schenectady, New York, and at their high-voltage laboratory in Pittsfield, Massachusetts where he was a design engineer in the transformer division. Since 1942, he has been associated with Crocker-Wheeler sales, first, as sales engineer in its New York office and then as manager of its Washington, D. C. office just prior to his recent appointment.

Mr. Lawrence has spent many years working with government agencies in Washington as a marine sales engineer on both mechanical and electrical equipment. Mr. Lawrence was originally with the Westinghouse Machine Company and spent twenty-two years with Westinghouse in Pittsburgh and Washington, resigning as Marine sales manager in 1937. He maintained his own engineering office in Washington until joining the Maritime Commission in the Fall of 1942 for the duration of the War.

Harris Pruitt, upon release from the U. S. Navy, has returned to the Salem Engineering Company of Salem, Ohio.

Previous to the outbreak of war Mr. Pruitt conducted his own engineering and equipment business. Early in 1941 he joined the staff at Salem Engineering, handling many important munitions equipment contracts. He continued in this capacity until the latter part of 1942, at which time he entered the service.

Simplicity!

CUSHIONS - RETAINING COLLAR - SPIDER

That's all there is to an L-R ---- but

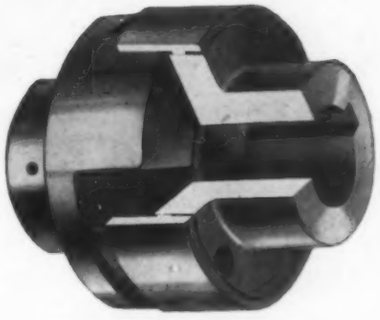
L-R CUSHION MATERIALS ARE ADAPTED TO EACH SERVICE!

And that's important. Cushions must withstand varying *kinds* of loads — heat — moisture — fumes — oil — grit, etc. L-R cushions are made of armored synthetic rubber, rubber duck, leather, brake-lining, etc., as conditions require.

L-R FLEXIBLE COUPLINGS

Most efficiently **correct for misalignment, take up shock, vibration, oscillation, backlash, etc. Extremely quiet. Cushions always in sight, for inspection. NO SHUT-DOWNS FOR CHANGING. Non-lubricated.**

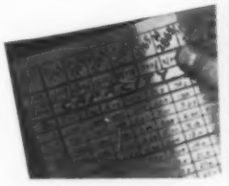
NEW L-R TYPE "C"



Patent and Patents Pending

Cutaway shows simple construction. Collar extension conceals readily accessible boltheads. Overall smoothness. Duties, 2 to 2,500 hp. One of many L-R types, ¼ hp up.

Send for complete Catalog, and Quick-Finding Selector Charts.



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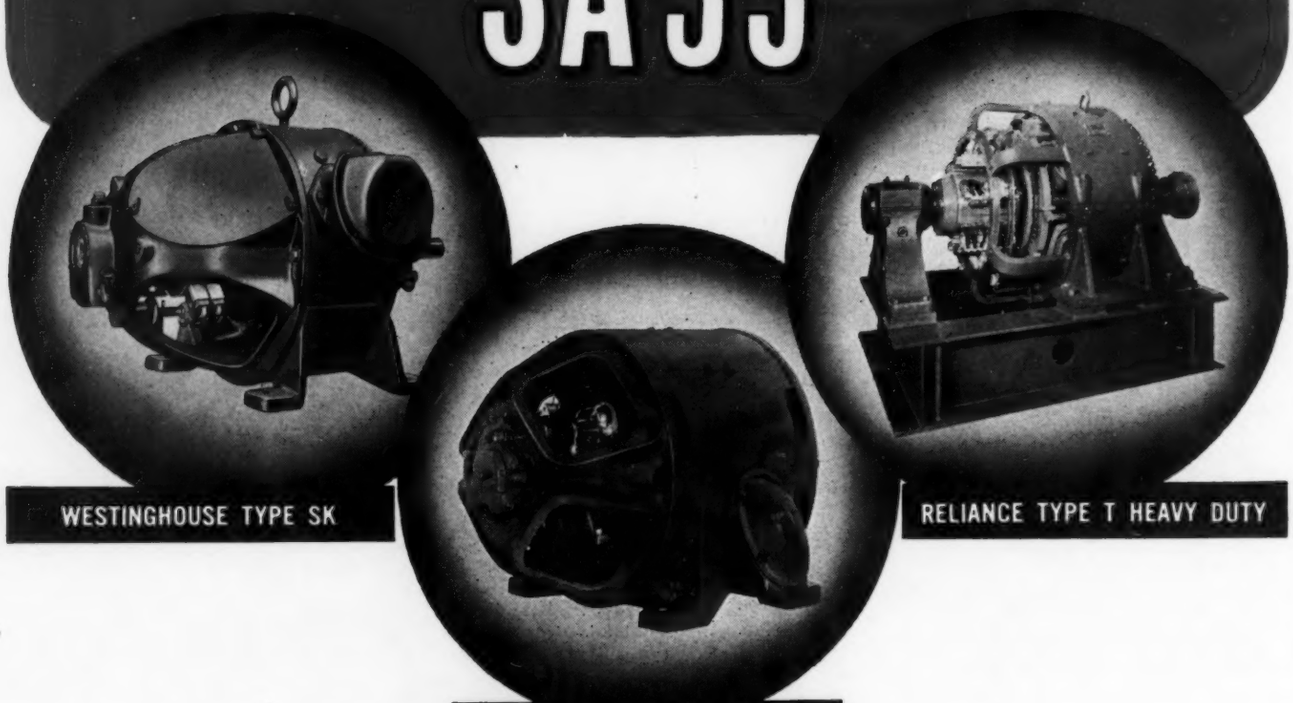
THESE MOTORS THRIVE ON

SA35



IN OUR OPINION, "National" Grade SA35 carbon brushes outperform all other grades on D.C. general purpose and heavy duty motors whether they be in mine, mill, shop or factory —on lathes, pumps, fans—on numerous industrial applications.

This brush, from the very day that it was introduced, has proven more and more dependable chiefly because of its commutating ability, uniformity in brush life and operating economy. For that reason we say—These Motors Thrive . . . On SA35.

Also adapted to heavy duty D.C. generators and rotaries and to reversing and continuous mill drives, grade SA35 is recommended as well for A.C. commutating type single phase and polyphase motors and repulsion-induction motors. Also for welding generators.

If you are not using "National" Grade SA35 on such equipment, we urge you to try it and learn at first hand of its most important feature—its *dependability.*

The word "National" is a registered trade-mark of National Carbon Company, Inc.

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FRED M. GILLIES

W. A. PERRY

H. W. JOHNSON

J. H. Walsh, vice president in charge of steel works for Inland Steel Company, retired from active service on January 1, 1946, in accordance with the company's retirement plan. He will remain a director of the company. Mr. Walsh was formerly superintendent of rolling mills in the old South Chicago Works of Illinois Steel Company. He came to Inland in 1922, serving as assistant general superintendent until 1927. He was general superintendent from 1927 to 1930, works manager from 1930 to 1941, when he was elected vice president in charge of the Indiana Harbor plant.

Fred M. Gillies, who has held the position of general superintendent of the Indiana Harbor plant, was made works manager on January 1, 1946. Mr. Gillies studied mechanical engineering at Cornell University. He left Cornell to become a naval aviator in World War I. His steel career began in 1910, working during summer vacations at the South Chicago works of the Illinois Steel Company. After the war he returned to Illinois but in 1922 came to Inland Steel Company as superintendent of the 100 in. plate mill. He was assistant general superintendent from 1930 to 1939 and in 1939 became general superintendent. Mr. Gillies has had long experience in general charge of the Indiana Harbor plant under Mr. Walsh.

A. P. Miller, who has been assistant to the general superintendent of the Indiana Harbor plant, became general superintendent. He graduated in mechanical engineering from the University of Pittsburgh. He was first superintendent of the open hearth department for Mesta Machine Company, and came to Inland in 1923 as assistant superintendent of No. 2 Open Hearth, and in 1937 was promoted to assistant general superintendent.

A. J. Cochrane, who has been in charge of the 19 in., 24 in. and 36 in. mills, was made assistant general superintendent. Mr. Cochrane attended Western Reserve University in Cleveland. He worked for the American Steel and Wire Company and came to Inland in 1928. From general mechanical foreman in the bar and blooming mill, he was promoted to superintendent of the 24 in. bar mill in 1936, and in 1940 was made superintendent of the 36 in. blooming and 24 in. bar and No. 1 billet mill.

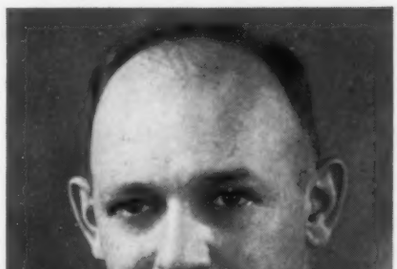
W. A. Perry, who has been superintendent of the electrical and power departments, become assistant to the general superintendent. Mr. Perry began with Inland Steel in 1910 at the age of 16, and has been with Inland for 35 years. By burning the midnight oil on his electrical studies, and advancing through the electrical and power departments, he has come to be known as one of the best posted electrical men in the steel industry. Mr. Perry is a past president of the Association of Iron and Steel Engineers.

H. W. Johnson, who has been assistant general superintendent of the Indiana Harbor plant, has been appointed staff assistant to the president, Wilfred Sykes. Mr. Johnson graduated from the University of Illinois, with a Bachelor of Science degree, and began work in the Joliet plant of Carnegie-Illinois Steel Corporation, later working at South Works as furnace foreman. He came to Inland in 1929 as assistant superintendent of blast furnaces. In 1930 he became superintendent of blast furnaces. In 1942 he was made assistant general superintendent. Mr. Johnson is widely known for his studies and contribution to the improvement of blast furnace practice.

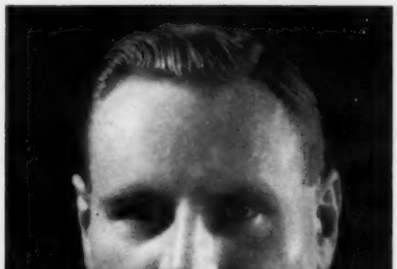
John M. Newman was recently appointed general engineering supervisor over steel mill, machine tool, brakes and drum controller divisions of Cutler-Hammer, Inc.

Mr. Newman is a native of Minneapolis, Minnesota. He received his technical education at the University of Minnesota, graduating with the degree of B. S. in E. E. in 1923. After graduation he joined the Cutler-Hammer organization as a student engineer and on completion of a specialized training program, became a member of the design engineering staff.

In 1928, Mr. Newman was promoted to engineering supervisor over standard steel mill control and in 1929, machine tool control was also placed under his supervision. In 1939 he took charge of all steel mill, crane and other heavy duty control equipment such as Hullett ore unloaders, coal bridges, etc.



ROBERT H. HOGE



R. L. PUETTE

DON L. ORTON

Robert H. Hoge has been appointed general manager of the Clark Controller Company. Formerly district manager of the company's district office in Gary, Indiana, and later in New York City, Mr. Hoge became assistant sales manager, moving up to sales manager. His many years experience in the electrical control field ably fits him for his new duties.

R. L. Puette becomes general sales manager, his former position having been manager of engineered and industrial sales. He has been with the company 15 years and enjoys a wide friendship in the steel industry.

Don L. Orton, formerly district manager of the Gary, Indiana district office is appointed manager of engineered and industrial sales. He has been with the company since 1929, and is well known in the steel and other heavy industries.

RECONDITIONED OIL CIRCUIT BREAKERS

Quan.	Make	Type	Amp.	Volts	Int. Cap.	Operation
1	Condit	Y-2	4500	2,500	350,000	Motor
1	R. S.	TS-100	2000	15,000	100,000	Solenoid
2	G. E.	FKR132B	1200	7,500	65,000	Optional
4	G. E.	FK132B	1200	7,500	65,000	Optional
10	Westg.	B13R	600	15,000	65,000	Optional
1	Condit	DZ-22	600	5,000	65,000	Optional
7	Condit	D-18	600	15,000	90,000	Optional
3	Westg.	B-5	600	15,000	90,000	Optional
1	G. E.	KR32C	600	15,000	90,000	Optional
8	G. E.	K-12	500	15,000	20,000	Optional
5	G. E.	K-132A	400	15,000	40,000	Optional
		OUTDOOR OIL SWITCHES				
10	G. E.	FK0136-1328AS	400	25,000	125,000	Solenoid
3	G. E.	FHK0136-1328Bs	400	15,000	200,000	Solenoid
4	Westg.	G-222	800	50,000	1,000,000	Solenoid

This is a partial list of our stock. Other sizes available. Send us your listings of surplus apparatus.

J. P. MANYPENNY

212 N. 21st Street, Philadelphia 3, Pa.

V. W. Bergenthal retired as an executive officer of the Wagner Electric Corporation on December 31. Mr. Bergenthal, who will continue to serve as a director, has been with Wagner for forty-one years or since November 1, 1904 when he took his first position with the company as assistant sales manager. In 1913 he was appointed purchasing agent and served in that capacity until 1922. In January 1922 Mr. Bergenthal was elected a director, and in August 1922 he was elected treasurer.

Mr. Bergenthal, who was born in Milwaukee, Wisconsin, received his A.B. degree from Marquette University in 1894, and graduated from the Electrical Engineering School of the University of Wisconsin in 1897. He moved to Pittsfield, Massachusetts, and began working for the Stanley Electric Manufacturing Company, moving to its Chicago branch in 1901, and to Wagner Electric three years later.

V. W. BERGENTHAL

Mr. Bergenthal is succeeded as treasurer by **J. D. Eby** who was elected secretary-treasurer of Wagner Electric Corporation effective January 1, 1946. Mr. Eby already held the position of secretary, having been elected to that position in September, 1945.

Ralph A. Powers has been named engineer-in-charge of electronic engineering at the Allis-Chalmers Manufacturing Company.

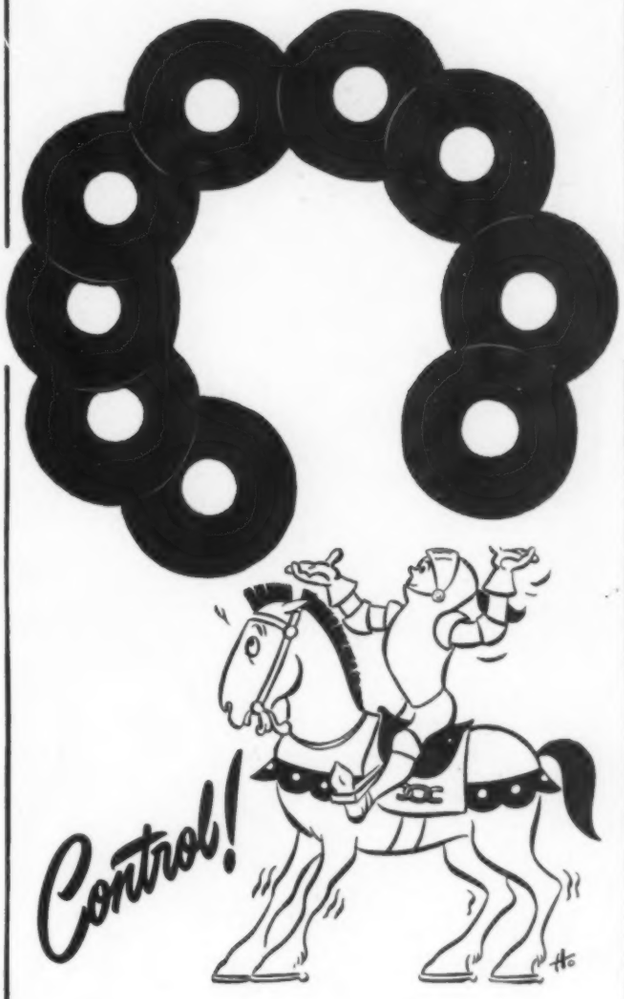
Mr. Powers, who holds numerous patents on electronic devices and has prepared more than a score of technical papers for trade groups and publications, formerly was with the Bundy Tubing Company, Detroit. He succeeds **J. M. Cage,** who has resigned.

Fred Reiser, Jr., Cincinnati district manager for the industrial division of The Timken Roller Bearing Company since 1944, has been named division manager for all divisions of the company there, including industrial, steel, automotive and service-sales, effective December 1, 1945.

Employed by the company August 11, 1933, in the industrial engineering department, Reiser was sent to Pittsburgh March 15, 1935, as a sales engineer. He was transferred to Cincinnati June 16, 1941.

Harry McCool, who joined The Timken Roller

MORGANITE
Carbon Piles



The juggler's control is easier of achievement if the objects being tossed are identical in every way.

His choice, in this case, is a happy one because "Link Control" is the guarantee that each piece is identical with its neighbor.

The "control" exercised at our mines, in the selection of raw material, is "linked" to the "control" practiced at each stage of manufacture. Each inspection is another link in the chain. With "Link Control" on the job you get every piece to exact specification.

Use MORGANITE and know you're right.

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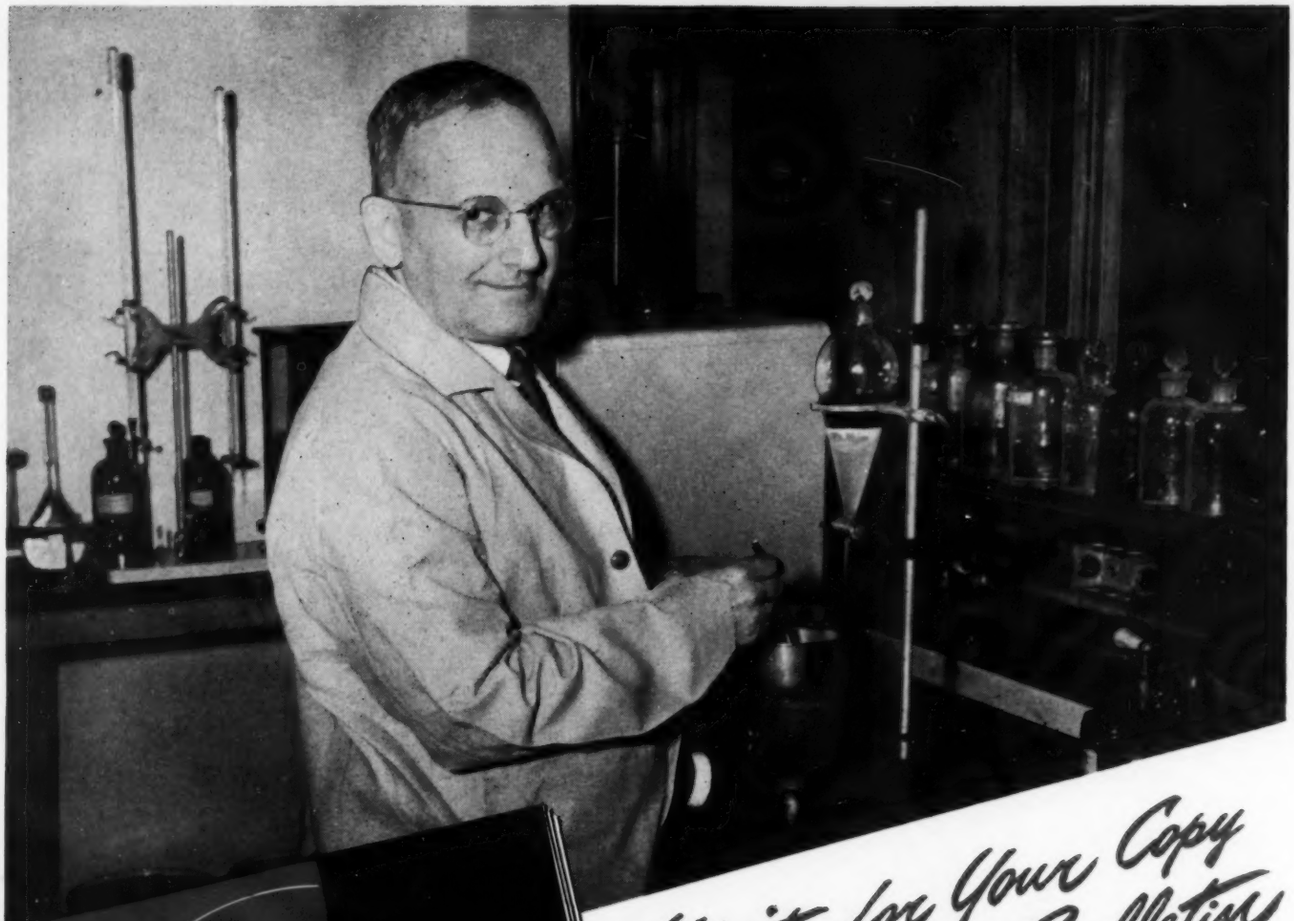

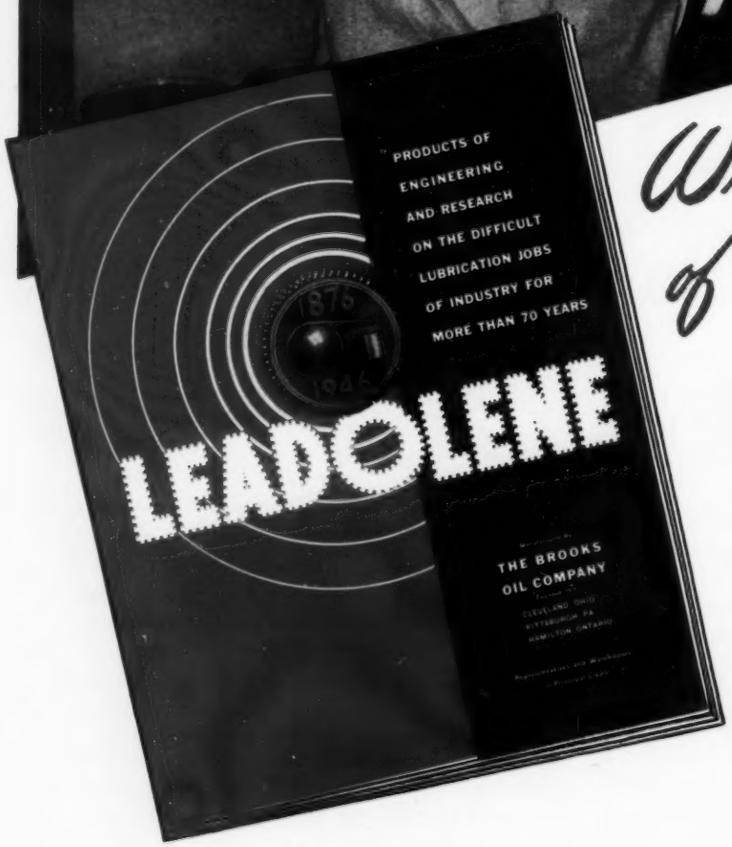

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The Brooks Oil Co.

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Cleveland, Ohio
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Warehouses: In Principal Industrial Cities

ASTOR L. THURMAN

FRANK O. LEITZELL

Bearing Company in 1928 as a hot mill operator, has been appointed sales engineer for the steel and tube division in Cincinnati district, which includes Indiana, Kentucky and part of Ohio, according to a recent announcement made by company officials.

Mr. McCool was promoted to the position of superintendent of the tube mill in Wooster in 1935 and remained on that job until March, 1941, when he joined the sales department of the steel and tube division. In 1942 he was assigned to the job of installing Assel shell mills in various ordnance plants throughout the country. Mr. McCool became field engineer on Timken graphitic steels for the territory east of Chicago in 1943.

Astor L. Thurman has been appointed electrical engineering chief for the Aetna-Standard Engineering Company, Youngstown, Ohio. Mr. Thurman comes to Aetna-Standard from The General Electric Company, where he served in the capacity of application engineer since 1941. Mr. Thurman brings with him a broad background of learning and experience in the electrical and mechanical engineering fields.

Edmund S. Murrah, formerly of the steel mill section, Industrial Engineering division, General Electric Company, Schenectady, has become associated with the research department of the Morgan Construction Company, Worcester, Massachusetts.

Frank O. Leitzell has been elected executive vice president of The Arms-Franklin Corporation with offices in the Mahoning Bank Building, Youngstown, Ohio. Mr. Leitzell was with the Lewis Foundry and Machine division of Blaw-Knox Company for ten years as vice president in charge of engineering and sales.

David B. Smith, director of the Philco research division since 1941 and an outstanding authority on radio, radar and television, has been appointed vice president in charge of engineering of Philco Corporation.

Mr. Smith joined Philco in 1934, after receiving the degrees of S.B. and S.M. in electrical engineering from the Massachusetts Institute of Technology, from which he was graduated in 1933 with high honors. Serving first as a patent engineer on radio, television and other applications of electronics, he was later placed in charge of a special advanced studies group in the Philco research and engineering department.

Mr. Smith was appointed technical consultant to the vice president in charge of engineering in 1938, and was promoted to director of research in 1941. In this capacity, he directed the fundamental microwave and ultra-high frequency research that led to the production of many important types of airborne radar used by the Army and Navy.

Charles E. Kline was elected to the position of vice president in charge of sales of the United Tube Corporation of Ohio.

Mr. Kline's experience has included association with several major steel plants — the Brainard Steel Corporation of Warren, Ohio, the steel and tube division of Republic Steel Corporation in the company's New York and Cleveland branches, and the strip division of Republic Steel.

Benjamin S. Dowd was elected president and general manager of the Vulcan Iron Works, Wilkes-Barre, Pennsylvania.

The accession of Mr. Dowd to the presidency marks another forward step in the development of a vigorous program for postwar expansion made necessary by a world-wide demand for the company's products — particularly from Argentina, Brazil, Mexico and other Latin American countries which Mr. Dowd, in his former capacity as executive vice president has visited extensively and throughout which he has established important sales connections.

Promotions announced thus far by Mr. Dowd include the appointments of **J. F. O'Brien** as director of purchases, **Geo. W. Walter** as works manager, **Jos. Lehnert** as production manager and **C. A. Netter** in charge of planning.

E. A. Goddard, general manager, Goddard and Goddard Company, Detroit, was elected president and **R. G. Michell,** president, Eclipse Counterbore Company was elected vice president of the Cutting Tool Manufacturers Association at the organization's second annual meeting.

Mr. Goddard succeeds **W. G. Robbins,** president, Carboloy Company, Inc., while Mr. Michell succeeds **O. L. Bard,** president, Michigan Tool Company. **R. H. Wolfe,** president, Arrow Tool and Reamer Company was re-elected treasurer of the CTMA, while **Harry J. Merrick** continues as its executive secretary.

Charles W. E. Clarke was elected vice president and consulting engineer by the board of directors of the United Engineers and Constructors, Inc. **Stanley C. Cook** was elected vice president and construction manager and **Benjamin S. Thayer** was elected vice president and construction manager.

James C. Barnaby, consulting engineer of Worthington Pump and Machinery Corporation, has been transferred to the general engineering staff at the Harrison Works as assistant director of research and development.

Fred Grotts, president of Fort Pitt Steel Casting Company since 1939, a former vice president of Lebanon Steel Foundry and superintendent of the American Steel Foundries, is now president of the Crum Lynn Foundry at Chester, Pennsylvania, a plant built by the Reconstruction Finance Corporation and operated by the Atlantic Steel Casting Company during the war period.

The new company, which is now in full operation and is known as the Chester Electric Steel Company, will specialize in carbon alloy and stainless steel castings. Other officers of the new company are **Stanley J. Roush,** vice president and treasurer; **William Burroughs,** plant manager; and **Sam Nicholson,** sales manager.

H. H. Barrows and his organization, the Industrial Equipment Company, have been appointed sales representative of the De Laval Steam Turbine Company of Trenton, New Jersey, throughout the lower Michigan peninsula, for the IMO Pump and Worm Gear divisions.

Mr. Barrows is well-known in the Michigan area, where he has had wide experience in the worm gear and oil handling fields for over ten years.

P. F. Kohlhaas, formerly chief engineer for Columbia Steel Company, San Francisco, is now vice president in charge of engineering with offices in San Francisco, California and Pittsburgh, Pennsylvania.

W. Kenneth Scott, formerly assistant chief electrician, Columbia Steel Company, Pittsburg, California, has been appointed electrical supervisor of new construction in connection with Columbia Steel's major expansion program in Pittsburg.

Oscar R. Olson is the chief executive and sole owner of the Olson Engineering Company, which is now engaged in building a number of industrial furnaces for steel plants and other organizations. Mr. Olson was formerly president of Pennsylvania Industrial Engineers which he founded in 1928. He headed it and the Amsler-Morton Company when they became divisions of Union Industries, Inc., in 1944. He relinquished this position recently to start the new company which bears his name.

Obituaries

Ernest Rehnberg, a lubrication engineer, with the Keystone Lubricating Company died January 2, 1946 at the age of 41. Prior to his engagement with the Keystone Lubricating Company, Mr. Rehnberg worked for the Armstrong Manufacturing Company.

THOMAS B. McELRAY

Thomas B. McElray, electrical superintendent of the Youngstown district of the Carnegie-Illinois Steel Corporation, since 1932, died Christmas day in Roanoke, Virginia, after being stricken with a heart attack as he was driving to Florida.

Mr. McElray went to work at Carnegie in 1900 as an oiler, and after one year was promoted to motor inspector. Three years later he became foreman of the electrical repair shop, where he remained for 10 years. He then became assistant superintendent of the electrical department and in 1932 was appointed electrical superintendent of the district.

Mr. McElray had been a very active member of the A. I. S. E., having served as chairman of the Cleveland District Section and as a national director.

Clarence L. Taylor, a life member of the Association of Iron and Steel Engineers, died recently. Mr. Taylor was vice president of engineering of the Arms-Franklin Corporation, where he had been since late in 1940. Before his connection with Arms-Franklin Corporation, Mr. Taylor was vice president of engineering of the Aetna-Standard Engineering Company, Youngstown, Ohio.

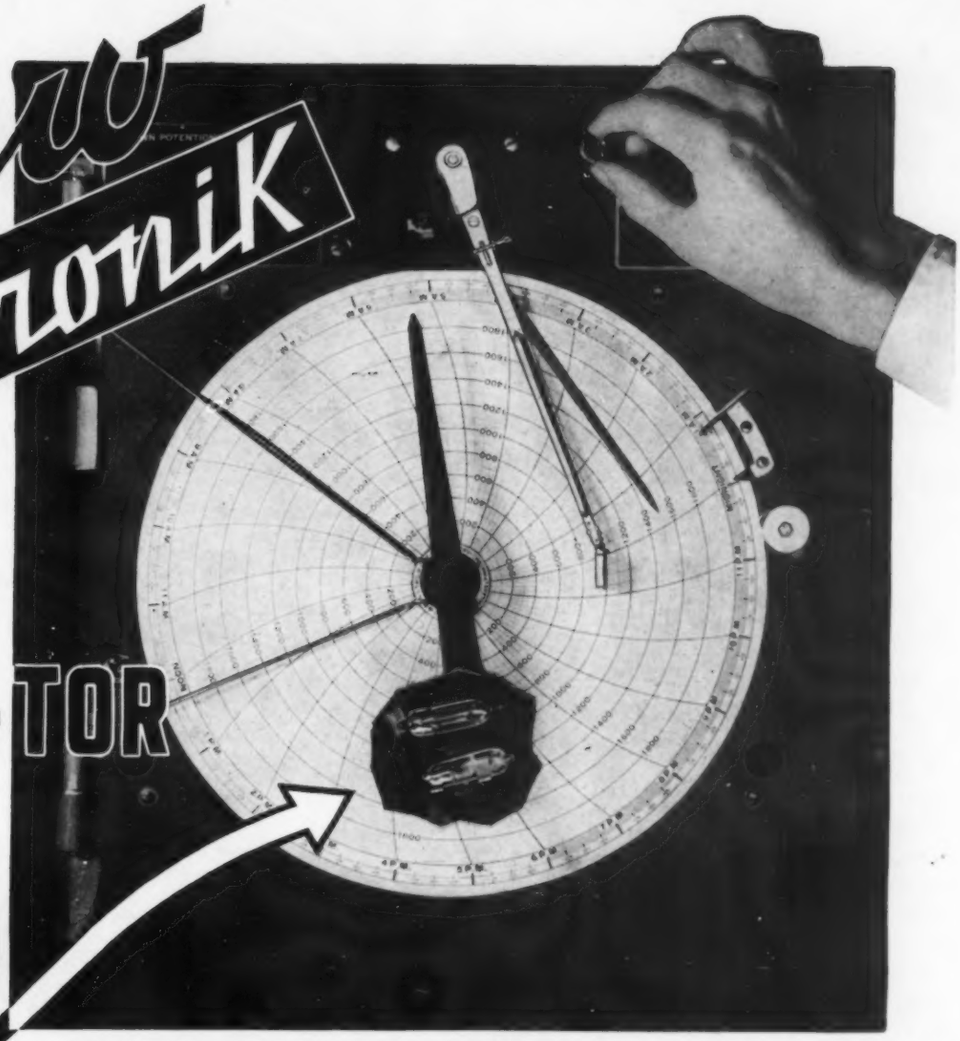
George E. Smith, 55, vice-president of The Midvale Company, Philadelphia, Pennsylvania, died suddenly December 12th.

Frank S. Warzeski, vice president of The Linde Air Products Company died after a short illness.

Mr. Warzeski was born in Chicago, Illinois, in 1884. He received his education at Chicago University, and Armour Institute of Technology in Chicago. He was graduated from the latter with a degree of Bachelor of Science in Chemical Engineering.

Mr. Warzeski began his association with units of Union Carbide and Carbon Corporation in 1912 as an engineer with The Linde Air Products Company. Subsequently he held many engineering and executive positions with subsidiary companies of Union Carbide. He was successively general superintendent, works manager, and vice president of the Linde Company and also held many other similar positions with other subsidiaries of Union Carbide and Carbon Corporation.

New Electronik



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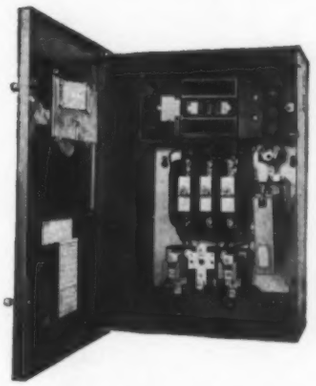

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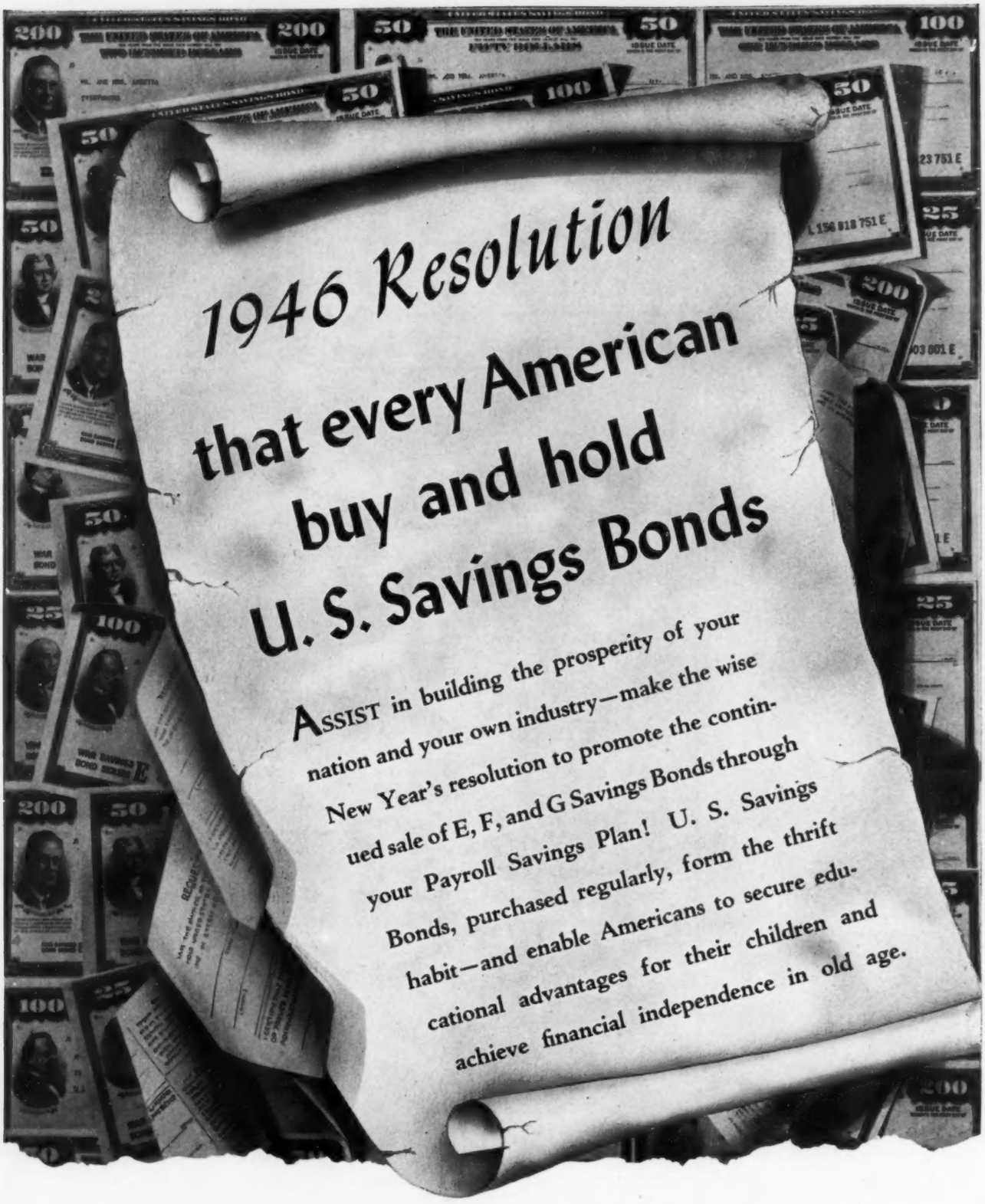
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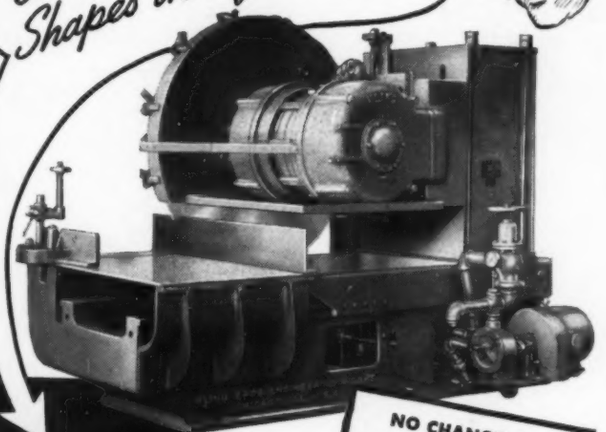

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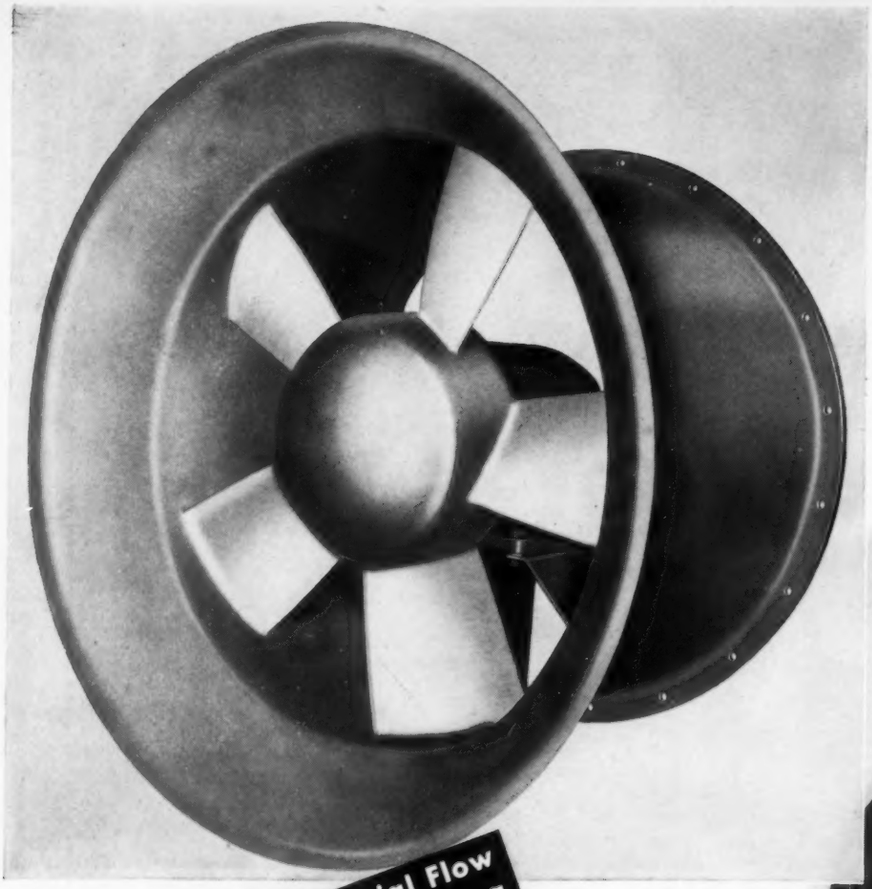

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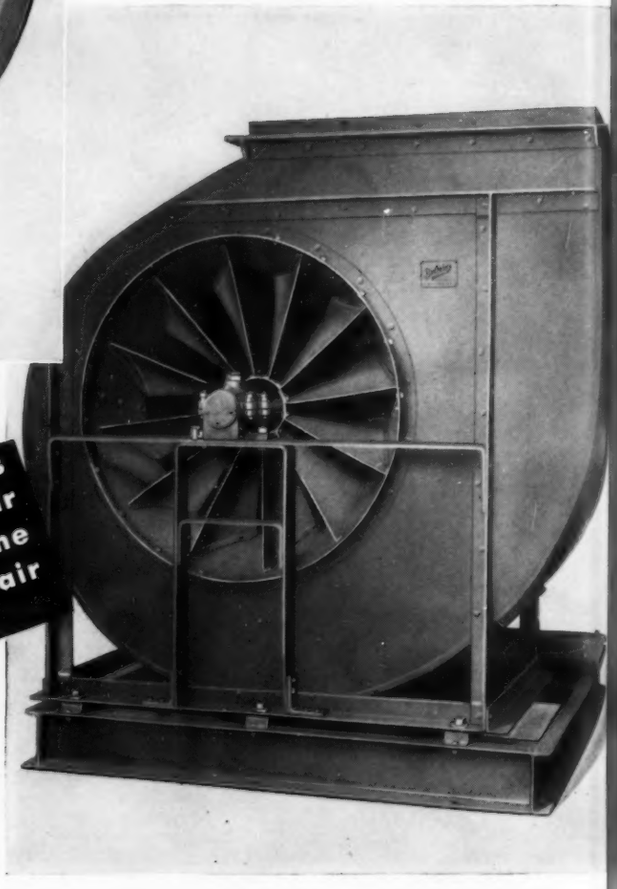

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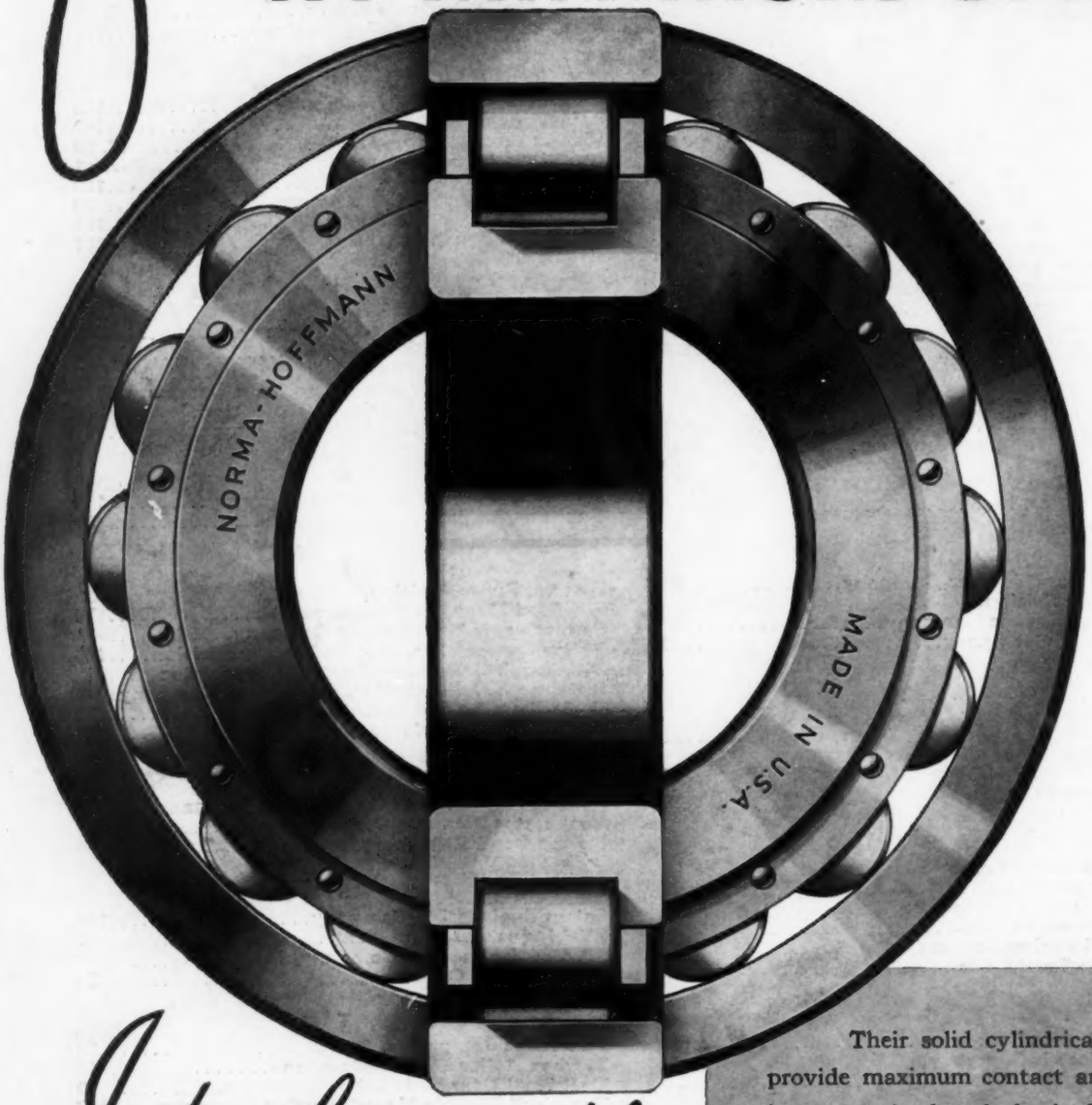

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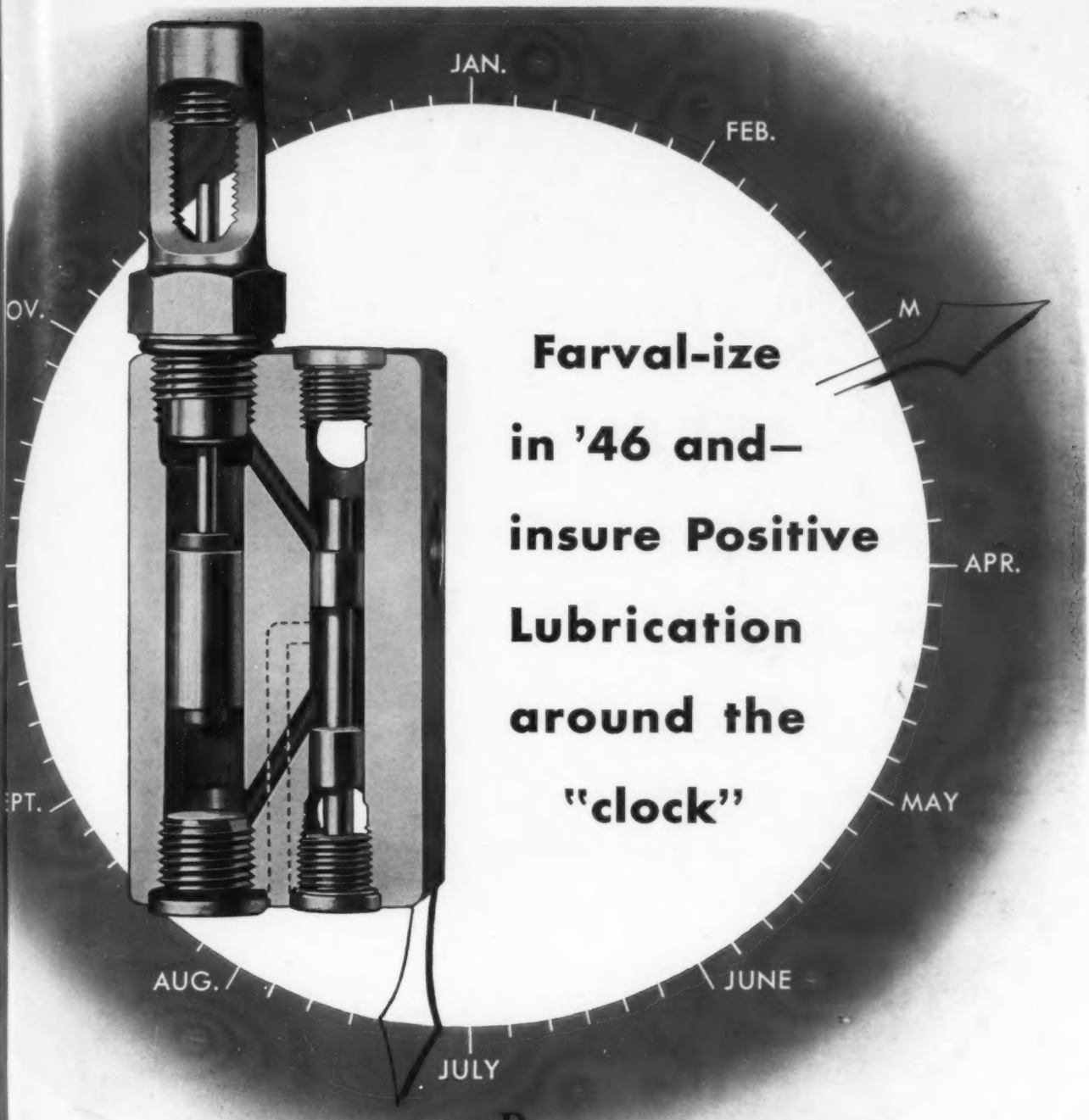

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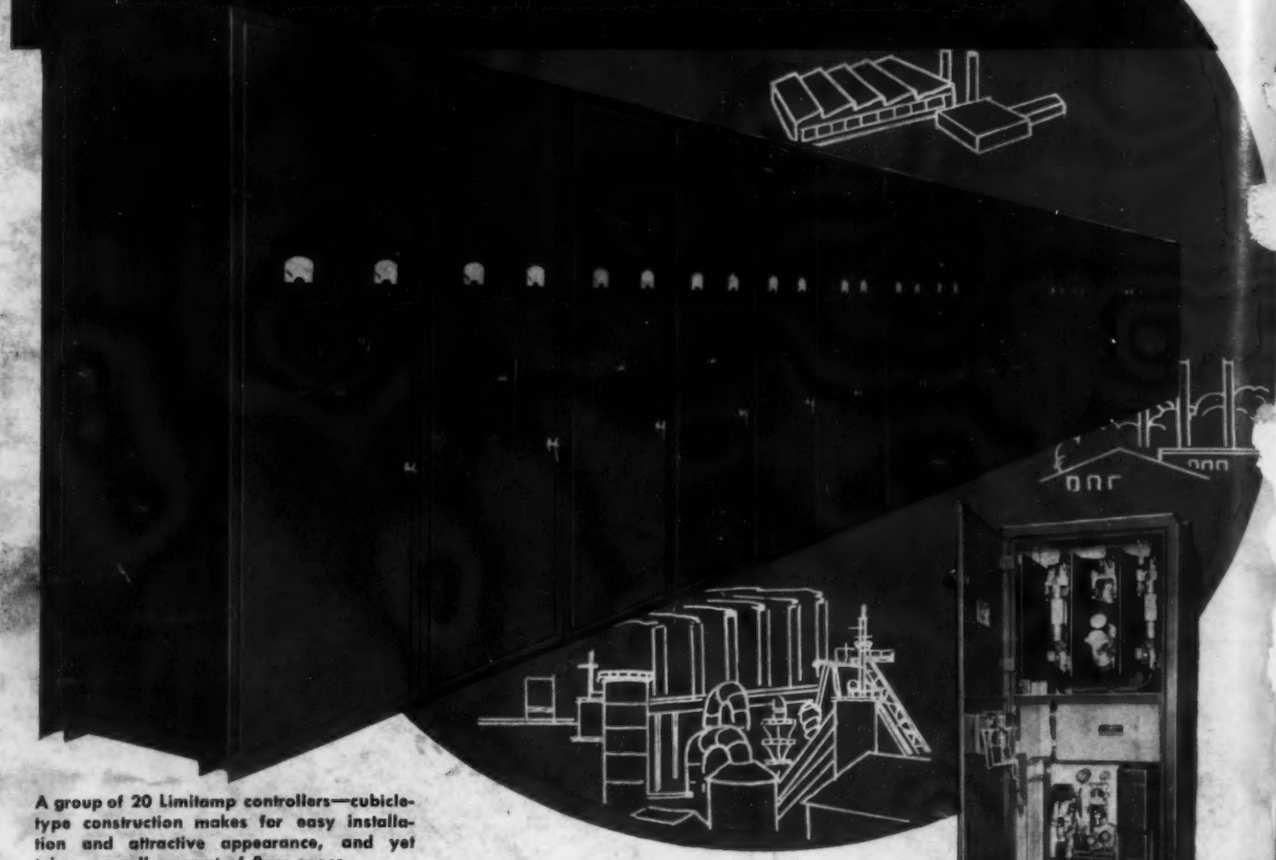

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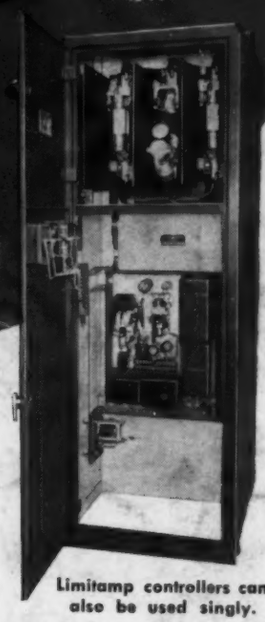

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